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FOR IBM PERSONAL COMPUTER USERS

PC TECH JOURNAL

3278/79 EMULATION

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3-D DRAWING WITH MEGA CADD

DATA MANAGER: REVELATION

SETS IN ASSEMBLY LANGUAGE

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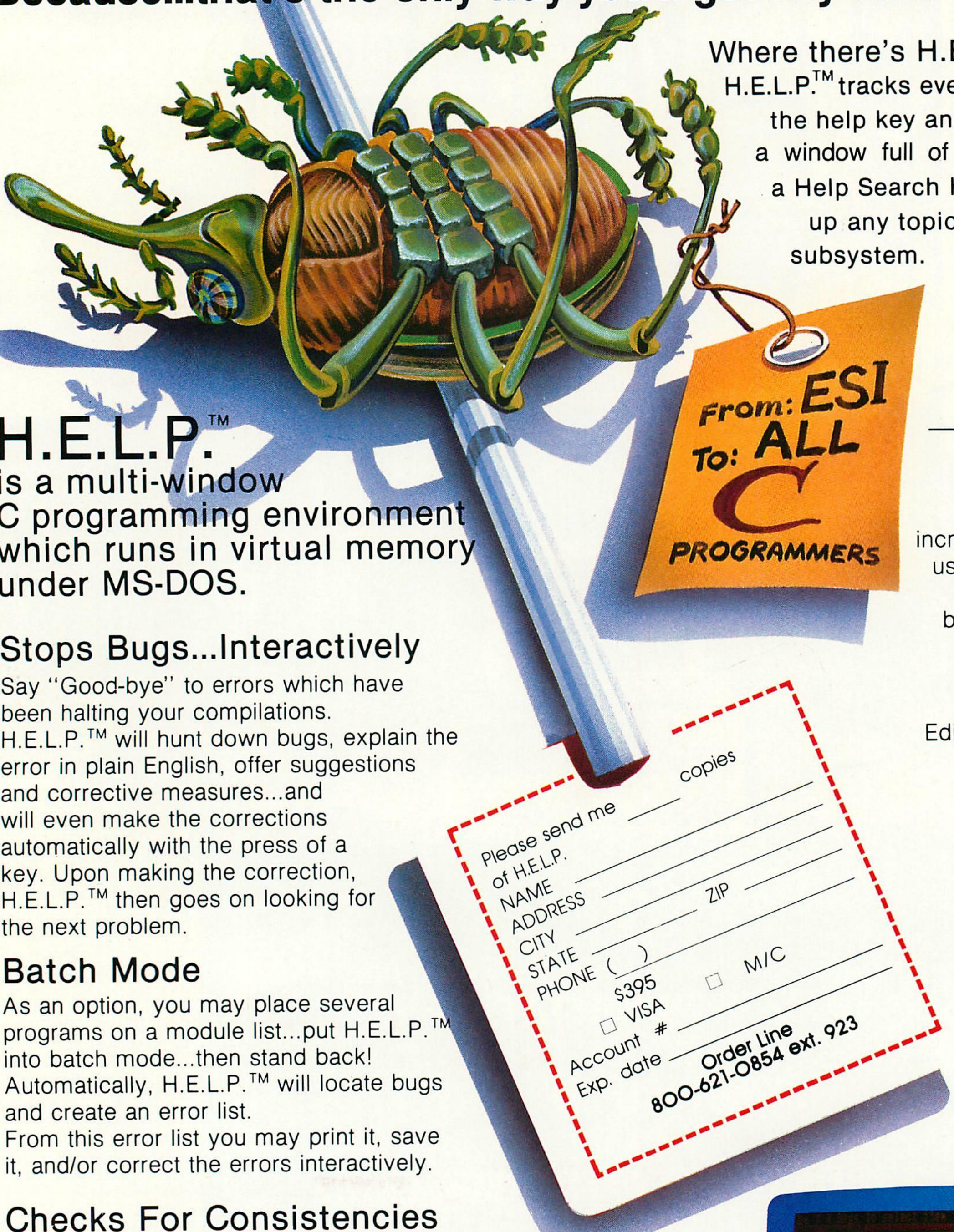

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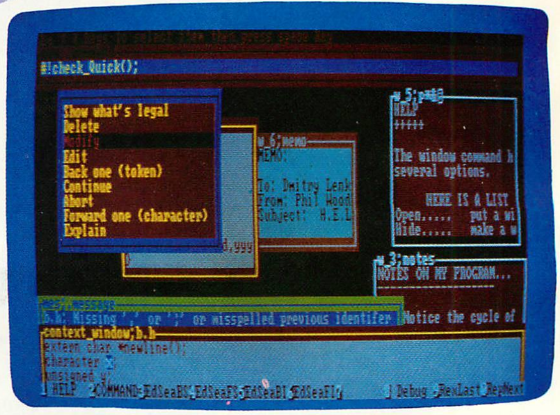

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"ZIM is...a successful migration of mainframe ideas and needs to a micro. (ZIM) proves not only that the job can be done but also that it can be done well. ZIM provides a reference against which current and future data bases can be judged." James Creane, Data Based Advisor/July 1985.

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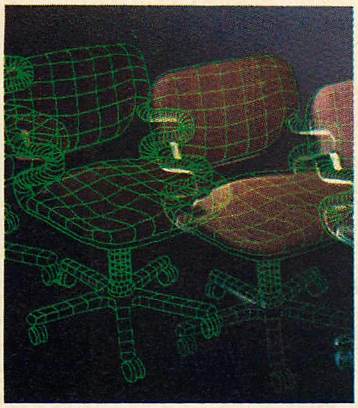

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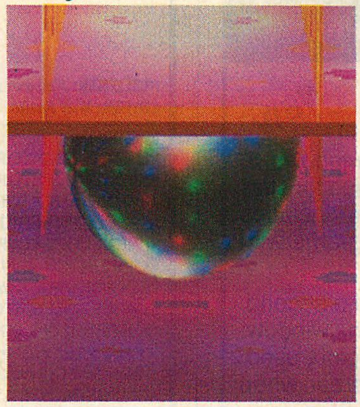

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Introducing Periscope II

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"Very powerful for debugging and testing. Great product! Better than Atron by far."
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[Periscope is] "the most essential element of my 'developer's tool box' . . . Every PC used for development at Microstuf has a Periscope board installed and in use on a daily basis . . . Anyone trying to write software on a PC who's not using Periscope is wasting either time, money, or both." —Jeff Garbers

Now there are TWO Periscopes! The original "board" model includes the write-protected RAM board. It is called Periscope I. The new "software" model does not include the write-protected RAM board. It is called Periscope II. We specify 'I' or 'II' only for features not in both models.

Periscope is "Always there with just a push of the button." Install the switch and software, then go about business as usual. Until your system hangs or the keyboard locks up or you just get curious about what's going on . . . then press the break-out switch and Presto! Periscope's debugging power is at your command. When you return to the executing program, it won't even know that Periscope has been there.

Save time with symbols and source code. They give you a roadmap through memory! Periscope uses names—symbols—from your program so you don't have to remember addresses. It displays source code and line numbers from high-level languages, too. You save hours of time because you access what you need with familiar names!

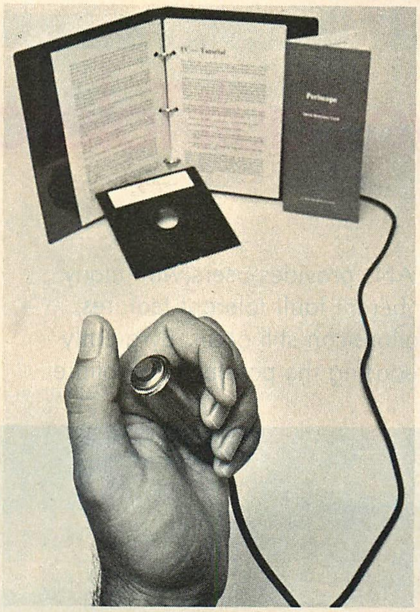
Can debugging be fun? With Periscope it can! Here's why:

It's Fast! Written entirely in assembler to save you time.

It's Easy! Commands similar to Debug's, optional on-line help, quick-reference card, tutorial, 150+ page manual, and support direct from the author—all you need to get up to speed quickly.

It's Flexible! You can:

- Enter Periscope via break-out switch, program loader, or assigned keys
- Define up to four windows for data, register, stack, and disassembly information; change them any time
- Display memory in ASCII, byte, word, double word, integer, or signed integer
- Design your own templates to display memory in easy-to-read formats
- Customize Periscope with your own programs via the user exit capability
- Assign frequently-used commands to function keys



The break-out switch really sets Periscope II apart from typical software-only debuggers. It installs easily, without taking an extra slot.

It's all there! Periscope includes all the standard debugger features, plus extras like supporting the use of one or two monitors, enabling you to search for address references, etc. The latest version includes new and enhanced features to help you debug your programs faster and easier than ever before:

New!	In-line Symbolic Assembler
Enhanced!	75+ Breakpoint Options
New!	Traceback
Enhanced!	Optional Windows
New!	Source-Level Debug
New!	View text files
New!	EGA Support
New!	User Exits
New!	8087/80287 Status
	Much More!

Periscope's unique breakpoint power forces bugs out from where they hide! With over 75 breakpoint options, including both temporary and sticky code breakpoints, you'll find elusive bugs fast. For instance, you can break on register, byte and word values; stop on execution of source lines and interrupts; break on reads and writes to ranges of I/O ports and ranges of memory using various tests. The memory breakpoint is great for debugging C programs with broken pointers. You can even write your own custom breakpoint tests!

Periscope requires: An IBM PC, XT, AT or close compatible; DOS 2.0 or later; 128K RAM; Disk Drive; an 80-column Monitor.

What Reviewers Say:

"This product is a reliable and useful tool for any programmer's workshop. A number of innovative, helpful features are yours for the taking." —Programmer's Journal

"Periscope has excellent on-line help. We were impressed by Periscope's very fast response in all its operations. It is a pleasure to use, and a refreshingly different product . . . offers great value and unique advantages." —Boston Computer Society

Debug any program, any time! Periscope is, in one user's words, "Robust". Use it to debug almost any program, even device drivers, memory-resident, and non-DOS programs. Debug when DOS is broken; debug DOS. Periscope won't let you down when you need it.

User calls Periscope I "Bulletproof"! The installation program in Periscope I loads the crucial debugger software into the RAM board and write-protects it. No runaway program can touch this code! Coupled with the break-out capability and the built-in reliability of the software, this protection gives you the most powerful crash recovery system available.

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Achieving a LAN Milestone.

Comprehensive Fault Tolerance for LANs.

In the development of any product or system, only a select few breakthroughs or advancements in technology are significant enough to qualify as milestones. Novell's introduction of System Fault Tolerant (SFT) NetWare is one of those milestones.

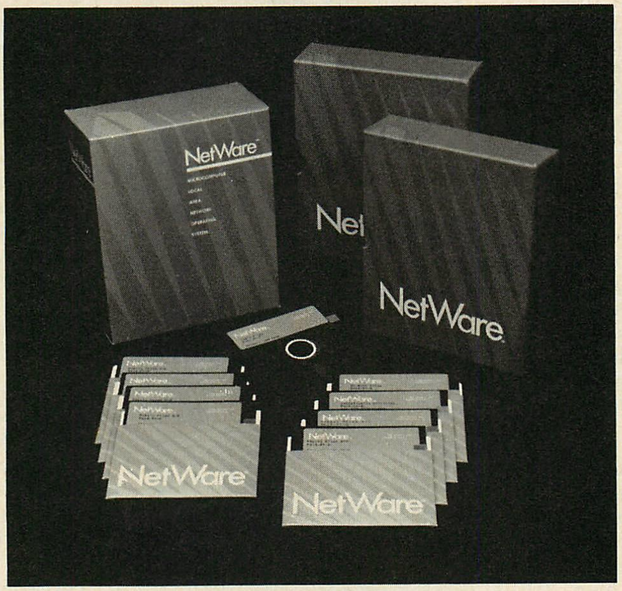
What makes SFT NetWare so significant? After all, other fault tolerant systems preceded the development of SFT NetWare. Even more important, who needs fault tolerance?

Data Disaster

Anyone who cannot afford to lose valuable data stored in a computer system needs fault protection. Whether for more traditional mini and mainframe systems or the office automation newcomer, local area networks, protecting against loss of data is a number one priority.

As the number of LAN systems being used to share information in business and industry continues to rapidly increase, the importance of LAN fault tolerance grows. Because as more and more data is stored and shared in a LAN system, the specter of a major data disaster looms larger and larger. And the need to avert such a disaster becomes critical.

While the distributed processing environment of personal computer LANs provides users with many inherent fault tolerant features, failure can still occur. By greatly reducing the possibility of failure and providing recovery capabilities, SFT NetWare represents a technological leap in fault protection for LANs. The result of that leap is higher system dependability to accompany the high degree of system flexibility and performance already provided by NetWare-supported local area networks.



Affordability

To make fault tolerance affordable for all LAN users, Novell designed SFT NetWare to utilize off-the-shelf components. In addition, the company wrote SFT NetWare to support 25 major LAN hardware systems.

These two important SFT NetWare characteristics effectively reduce the cost of SFT NetWare to a mere fraction of the cost of other fault tolerant systems. Instead of having to pay for a complete, new proprietary system to get fault protection, in most cases LAN users can now simply add fault tolerance capabilities to their existing LAN systems.

And three varying levels of SFT NetWare allow users to tailor their fault tolerant LAN systems to their specific needs and budgets.

SFT NetWare Level I

Level I provides basic directory and data fault prevention for LAN systems at a minimal startup cost. Through several specific functions like redundant directory structures, read-after-write verifications, and error detection and correction, SFT NetWare Level I protects and preserves data in case of disk media failure.

A particularly innovative function of Level I is Hot Fix. If a faulty area of the disk is encountered during the read-after-write verification, it is marked as "bad" and listed in the bad block table. The data is then relocated to a known good area without affecting the normal operation of the workstation and server interchange of information.

SFT NetWare Level II

While the Level I Fault Tolerant System is designed to prevent basic directory and data faults, Level II provides an additional measure of safety through mirroring and duplication of all data. At this level, fault tolerant data storage for the LAN is accomplished either by duplicate storage units on a single controller (mirroring), or by doubled components, including controllers, drives and power supplies (duplexing).

Having duplicate drives, controllers and channels allows "split seeks" to occur on disk reads. The server examines each read request and determines which drive can respond to service the request most quickly. When two or more read requests are presented to the server, they split and occur simultaneously, effectively doubling the system read performance.

SFT NetWare Level III

Level III combines all of the LAN fault tolerant functions of Levels I and II with duplexed file server operation. Two file servers are interconnected using high-speed bus transfer hardware.

If one server fails, the other server automatically takes over network operation. When the failed server is repaired, it resumes its normal network functions. The entire sequence is completed without downtime or loss of data, and is totally transparent to the user and to the application software running on the workstation.

Transaction Tracking System

A major feature of SFT NetWare Levels II and III is the Transaction Tracking System (TTS). TTS ensures that the LAN system views database changes as a single unit of work (a transaction) which will be either wholly completed or wholly backed out.

If a system failure occurs during a transaction, TTS rolls back all database changes made by the transaction, returning the database to its previous point of consistency. Only the failed transaction is lost, leaving the database in its original form (before the transaction was begun).

During normal operation, TTS records periodic "snapshots" of its database files, as well as an audit trail of updates made since the most recent snapshot. In the event of a catastrophic system failure, TTS performs a rollforward recovery, restoring data to the point of the last snapshot, then applying the audit trail to reconstruct remaining files from the archive copies.

"Anyone who cannot afford to lose valuable data stored in a computer system needs fault protection."

With TTS functioning, virtually any real-time application—such as spread sheets, accounting systems, database managers—can be implemented on the LAN system with disaster prevention.

Summary

The impact of SFT NetWare on the future of local area networking is most significant. Just as the file server revolutionized the industry and set a standard of LAN performance, System Fault Tolerant NetWare is setting a new standard of LAN reliability.

With that reliability comes all the functionality of NetWare LAN Operating System software. Advantages like unsurpassed speed, multilevel security, and over 2,000 available applications. Plus DOS 3.1 compatibility, allowing NetWare to run any applications written for the IBM Networks.

And because SFT NetWare runs on 25 major LAN hardware systems and utilizes off-the-shelf components, an affordable system of fault tolerant data protection is available right now for the majority of LAN system users.

Although no LAN system can guarantee against any failure, SFT NetWare makes enormous strides in reducing the possibility of failure. This major milestone in LAN technology means greater safety of LAN system data and improved efficiency in LAN operation, for surprisingly little cost.

For more information, order the SFT NetWare Technical Description by writing or calling:

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Introducing a shape that's about to turn on an entire industry.

The Softstrip™ data strip. From Cauzin.

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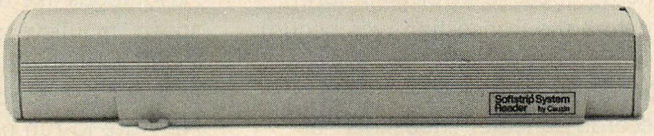


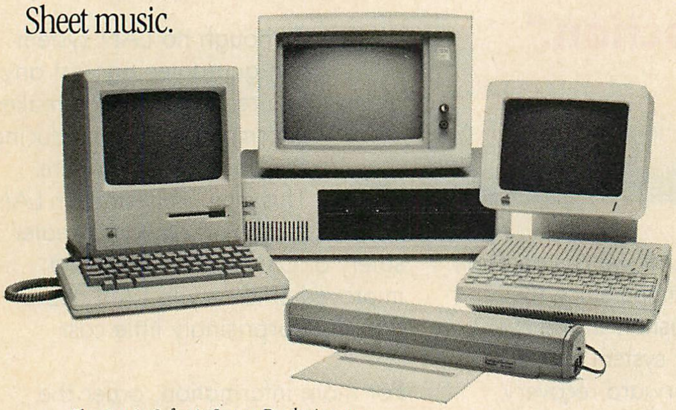
The Cauzin Softstrip System Reader replaces tedious typing by scanning the strip and reading it into your computer.

Creating a simple, reliable and cost efficient way to distribute and retrieve information.

Softstrip data strips, like those you see here, can contain anything that can be put on magnetic disks.

Facts. Figures. Software programs.

Video games. Product demonstrations. Sheet music.



The Cauzin Softstrip System Reader is now compatible with the IBM PC, Apple II and Macintosh.

A single strip can hold up to 5500 bytes of encoded data.

It can stand up to wrinkles, scratches, ink marks, even coffee stains.

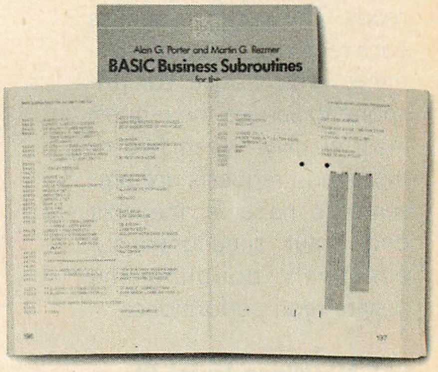
And it can be entered into your computer with a higher degree of reliability than most magnetic media.

Simply by plugging the Cauzin Reader into your serial or cassette port and placing it over the strip.

The reader scans the strip, converts it to computer code, and feeds it into any standard communication interface.

Because strips are so easy to generate, most of your favorite magazines and books will soon be using them in addition to long lists of program code.

And you'll be able to enter programs without typing a single line.



Soon everyone will be stripping as data strips appear in popular magazines, computer books and text books.

There is also software for you to generate your own strips. Letting you send everything from correspondence to business information using our new technology.

Find out how much you can reveal by stripping. Just take this ad to your computer dealer for a demonstration of the Cauzin Softstrip System Reader.

Or for more information and the name of the dealer nearest you, call Cauzin at 1-800-533-7323. In Connecticut, call 753-0150.

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835 South Main St., Waterbury, CT 06706

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Here are two programs you can run by stripping. Just take this ad to your dealer for a demonstration.

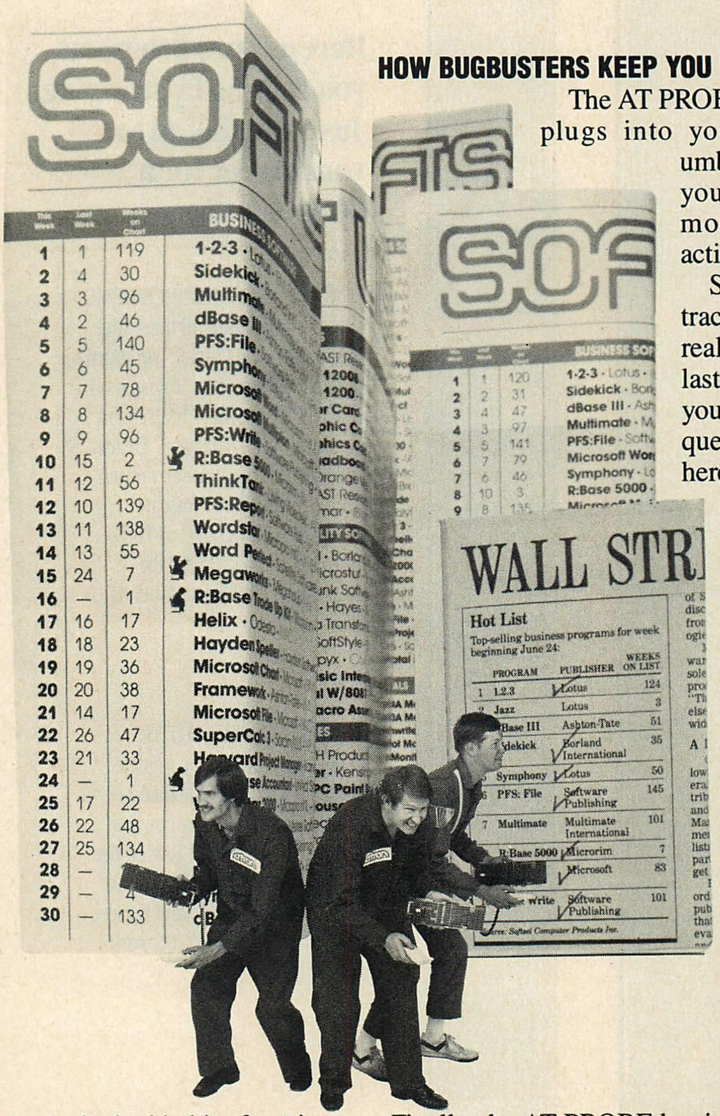
1 TURBO PASCAL GRAPHICS DEMO
These strips contain all the source code for a Turbo Pascal™ program to demonstrate graphics. To use it on an IBM PC or compatible, read in the strips with a Softstrip™ Reader and then treat just like any other Source file for Turbo Pascal. (If you don't have a PC or Turbo Pascal, you can still read the source code. The file is standard ACSCII text.)

2 STRIP DEMO WITH LOTUS
These strips contain a complete LOTUS™ worksheet file that demonstrates and explains the power of Softstrip™ technology. To view the demo, just read the strips into an IBM PC or compatible and retrieve them from a blank LOTUS worksheet (eg. /FR).

1a | 1b | 2a | 2b

Atron's PC/AT Bugbusters

Hardware-assisted Software Debuggers for Bullet-proof PC/AT-based Products



A BUGBUSTER STORY

Brad Crain, a project manager at Software Publishing (the people who developed both PFS:WRITE and PFS: FILE), relates the following: "On Friday, March 22, 1985, I was about to get on an airplane with Jeff Tucker, who was co-author of PFS:WRITE with me, and fly to IBM's Boca Raton, Florida facility. For a week, we had been unsuccessfully trying to isolate a bug in a new software product. In a last, desperation move, I set up an early-Saturday morning appointment with ATRON.

"Three of us walked through ATRON's door at 8:00 the next morning. Using ATRON's hardware-assisted debugging tools, we had the problem identified and fixed by 10:30AM."

Mr. Crain concludes: "We'd never have found the bug with mere software debuggers, which have the bad habit of getting over-written by the very bugs they're trying to find. It doesn't surprise me that almost all the top-selling software packages were written by ATRON customers. Now that they've broadened their PC family of debuggers to include a PC/AT debugging tool, those of us seriously into 80286 development are greatly relieved."

ARE YOU TRYING TO DO SOMETHING SCAREY?

Like developing your AT-based software product in the dark? Without professional debugging tools?

Seven of the ten top-selling software packages listed by the *THE WALL STREET JOURNAL** were produced by ATRON customers. The PC PROBE™ bugbuster ($1595) accounts for much of this success. Now that the PC/AT is the new standard for advanced commercial and scientific development, ATRON is proud to announce the AT PROBE™ bugbuster ($2495). It has even more debugging capabilities than the PC Probe.

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Impressions from COMDEX

Surprises? Not many, but we did find some indicators of future direction.

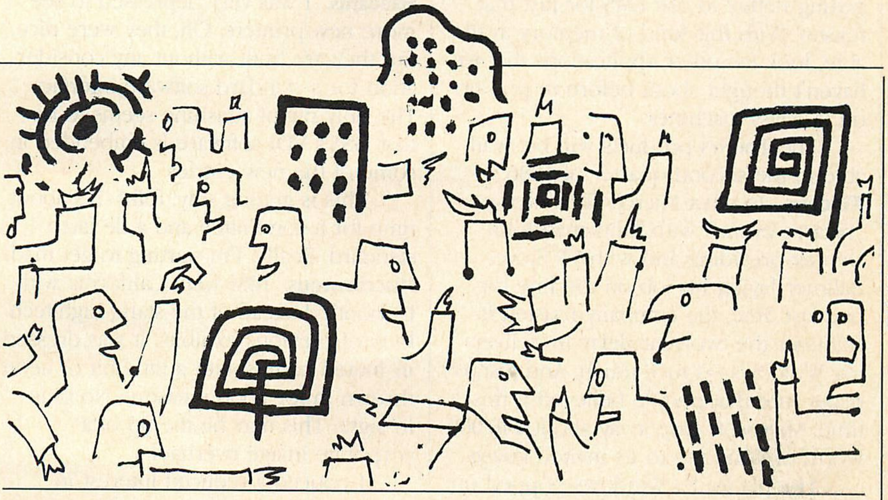

ILLUSTRATION • MACIEK ALBRECHT

Without a doubt, the Fall COMDEX has become the desktop computer industry's most important trade show. The proof is in the judge's mouth: although many vendors griped about last year's mediocre turnout, the show's dullness, the high cost of show space, and the miserable weekend scheduling, COMDEX this year drew at least as many vendors, filling the entire convention center and four hotels with exhibits. On Friday, the middle day of five, the aisles were crowded; attendance seemed heavier than last year.

PC Tech Journal added to that attendance. Six of our editors and five of our contributing editors spent a full three days on the show floor scouring booths for even a hint of excitement. Brief comments from the other editors are presented on the next page; here are my impressions.

Atari 520ST. It may seem strange for me to report on an entirely different product line, but concentrating, as we do, on the IBM standard is sometimes like wearing blinders because the standard makes new developments seem natural, almost expected. Seeing other work on other types of computers is refreshing and provides different perspectives.

The new Atari might actually succeed *if* Atari can keep the cash flowing and *if* the 520 is built well and *if* distribution can be developed and maintained, etc.—all big *ifs*. At COMDEX, Atari had a slew of third-party software developers take over its booth to show their wares. It was an impressive sight. Ataris could even be found in other booths. And, best of all (for Atari, that is), neither Commodore nor its Amiga was anywhere in sight.

The prevailing opinion is that the low cost of the ST, as compared with Amiga, is the lure. The ST is a closed machine; such vibrant aftermarket activity can mean only that developers believe in the hardware. This is an interesting lesson for the low-end players. I would have to have a *very* good reason to suggest buying a PC*jr* now.

Expanded memory. The biggest surprise for me was the widespread acceptance that the Lotus/Intel/Microsoft Expanded Memory Specification (LIM EMS) has received. In just a little more than six months, 30 major programs either have been converted or are undergoing work to make them compatible with the expanded memory spec.

Some companies are building software products that can *execute* out of EMS. At first, the product was largely touted as a place for *data* because Lotus announced that 1-2-3 version 2.0 would support EMS, thus allowing larger spreadsheets to be constructed. Expanding the executable memory space is much more important, however, if judged by nothing else than the popularity of resident software and the ability of products such as Microsoft Windows to run more than one program, with performance directly dependent on available executable memory. A RAM disk helps Windows a lot, but not having to swap at all is the bigger benefit.

Skeptical at first, I now consider the LIM EMS a de facto standard. The close connection between Intel and Microsoft implies that EMS will be more tightly coupled with the operating environment in the future, perhaps even soon. That may be the most important result of Intel's strategy.

This must be embarrassing for IBM. The after-market has spoken loudly by demanding a longer life for the six million or so PCs out there. IBM didn't deliver. Intel and its partners did.

$800 memory. The shocker of the show was the announcement from TheSys of an add-in memory board holding 8MB of RAM. Actually, the board has 12MB on it; 4MB are used for ECC. Fully populated, this board costs $800. And it is EMS-compatible. Want more? It is *CMOS*. Not content? TheSys also introduced a 16MB solid-state hard disk—a box full of RAM with your choice of disk interface. Buy the unit, plug it into your hard-disk controller, and away you go with a hard disk that boasts an average access time of 10 microseconds (about 8,000 times faster than the XT hard disk). Again, it is CMOS and can be backed up with batteries.

The memory chip used in this product is one megabit, but it is packaged in a unique fashion. The package contains 10 chips: 8 for data, 1 for parity, and 1 spare, for a total of 1MB per package. The package is the size of a stick of chewing gum and just a tad thicker, so 12 of them fit nicely on a PC board. This is a proprietary TheSys technology, so don't look for it from

other vendors unless TheSys takes on equity partners (a distinct probability) or turns generous enough to license the product (I wouldn't).

This kind of RAM capacity bodes well for all kinds of workstation products, from graphics to artificial intelligence. It also bodes well for data management products, which can be greatly improved in performance if the data are RAM resident. I am willing to bet that Borland will break all speed records in getting Reflex to use EMS for just that reason. With this kind of memory available, look for other applications that we haven't thought about before to pop up on PC-class machines.

The TheSys products will be available in the second quarter of 1986.

Windows. In what Microsoft labeled a "bizarre event," with funnyman John Dvorak presiding and with VP Steve Ballmer laying his job on the line for one last time, the company roasted itself over the two-year delay in delivering Windows—a nice touch. And just to make sure that people believed it this time, Microsoft gave away about $40,000 worth of Windows to its invited guests.

Hoopla aside, Windows popped up (pulled down?) everywhere. I was most impressed to see it on the Vectra PC, Hewlett-Packard's new AT clone. HP has a strong presence in the lab and scientific markets; it is, in effect, endorsing Windows to a very technical community of users who are interested in graphics and realtime support.

A big job still lies ahead for Microsoft. We must wait and see what kind of software the after-market provides and how long it takes for Microsoft to get code running in EMS. Windows is not yet a standard; more time (and nail biting on Ballmer's part) is required before we will know for sure.

Standards. I was very depressed to see more new printers. Oh, they were nice, but they are built without any consideration for a standard software interface. The only ray of sunshine seems to be that GSS's VDI software is embedded in some of the new entries.

This is getting silly, folks. It's about time for a committee and a de facto standard. Really. I'm starting to get mad.

Miscellaneous. IBM went California with its booth. Instead of the stark, high-tech look of previous exhibits, it was dressed in muted pastels with a little bit of neon thrown in for good measure. No blue in sight. This may be the tip of a corporate image overhaul.

I noticed a reduced interest in accelerator boards. This may be due to the high interest in EMS as a way of extending the PC's life, as well as to the fact that adding one of these boards often reduces a 100-percent pure IBM to the status of a clone. It may also be due to the fact that those of us who want to upgrade are out of slots. Spending six grand to upgrade the PC does not make much sense when that amount of money will buy an AT.

Network activity was high in the wake of the IBM Token-Ring announcement. PC to mainframe was not much in evidence, which is not surprising for a show catering to dealers (as in computer, not card).

The data management arena produced three items of news. Many firms announced multiuser/network versions of their products, a sign that network activity in the coming year will be high. Ashton-Tate announced dBASE III Plus, a natural evolution from dBASE III that can stand on its own legs, but the announcement seemed defensive, as if A-T felt that Ansa's Paradox had to be answered feature by feature. Unify announced a DOS version of its product, significant because of its penetration in the UNIX marketplace.

Finally, we were gratified at *PC Tech Journal*'s acceptance. We ran out of copies of the two issues we displayed in our booth, and we were delighted to see so many vendors displaying "As seen in ..." placards of the ads they have run with us. Thanks.

THE AGENTS REPORT

Stepping over so many laser printers in order to see the rest of the show can only spell out (alas, in 300 DPI) only one thing: exciting advances to come for publishers.

—Marjory Spraycar

As data managers move down from mainframes and minis to the microcomputer, I see a growing sophistication in meeting the needs of serious developers and a blending of the virtues of each world.

—Julie Anderson

Laser printers were everywhere, with Tall Tree's JLASER driver board the most notable product in that area.

—Jeff Duntemann

The industry is recognizing the difference between graphics programs and true CAD systems. It was exciting to see products like VersaCAD and CAD MASTER responding with refinements to their products.

—Caroline Halliday

COMDEX '85 spanned the range from practical to exotic; for $2,000 you can have a PC/AT clone, a 550 Meg laser disk system, or a Voice Recognition package.

—Dan Beale

Everything I saw fit on or ran in the IBM PC. Even Apple and Data General connect to the PC. Laser printers and software were plentiful, as were compact-disk ROMS. I was bowled over by the IBM PC Story Board.

—Tom Hoffmann

The most visible trend is the increasing conformance to new standards as attested to by the numerous AT clones and by the widespread acceptance of the Lotus-Intel memory specifications. I saw a lot of laser printers—but no good prices.

—Steven Armbrust

Cheap, dense, high-speed memory is coming out of adolescence as evidenced by half-height RAM disks complete with batteries. I expect shortly to see all this memory put to qualitatively different uses.

—Richard Foard

I noticed that the knowledge and expertise of people manning the booths were inversely proportionate to the size of the booth. Unfortunately, at COMDEX most of the booths were very large.

—Ted Forgeron

I was pleased to see the merging of UNIX and DOS exemplified by Insight from UNIDOS Systems Corporation and OS Merge, a feature of AT&T's new UNIX System V.

—Augie Hansen

What makes COMDEX worthwhile are the vendors who occupy a small part of a larger company's booth or those too small even to share a booth. Their products are often new to me and display real creativity.

—William J. Hunt

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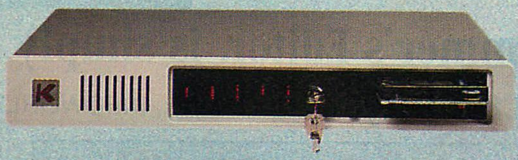

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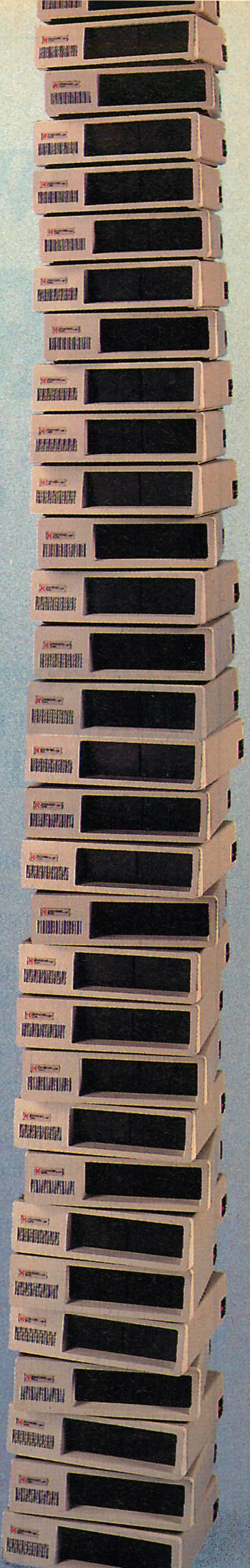

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STORAGE MEDIUM

I really cannot see what all the fuss is about in the article "Moving up to Tape" (Steven Armbrust and Ted Forgeron, November 1985, p. 62).

Some day, hard-disk technology (and tape backup) will be a thing of the past. Today's event is the concept employed by IOMEGA in its removable cartridge system. The Bernoulli Box is expensive, but hard-disk storage was considered likewise at one time.

When we considered storage needs for our central services/data processing department, hard disk was the last thing we looked at. For versatility, ease of use (including backup), value, and ruggedness, the Bernoulli Box was first. We currently employ one system (two-cartridge, 10MB each), but should we consider more storage later, the Bernoulli Box will be our choice again.

I asked myself, as I read your article, who really wants to put up with even the possibility of head crashes and/or selecting the right backup system? Not me, not us, not ever.

Dan Davis
Bank of Loleta
Eureka, CA

No one denies that cartridge disks have their place. Their removability lends them neatly to securing sensitive data, and backup is done simply by copying all the files on one cartridge to another. Also, with multiple cartridges, a limitless amount of data can be stored. However, in the configuration you describe, a maximum of 20MB of data can be on-line at one time and a maximum file size is imposed equal to the capacity of one cartridge, or 10MB.

Nonremovable hard disks are available in large capacities, with some vendors offering disks that allow files greater in size than the DOS-imposed 32MB barrier. As for reliability, head crashes may occur on cartridge-based systems as well as nonremovable hard disks; the Bernoulli Box and the IBM 10MB fixed-disk drive each have an MTBF of 8,000 hours. As tape backup becomes easier, faster, and cheaper, its popularity will increase.

Each type of mass storage carries with it a set of advantages and disadvantages that must be weighed against individual needs.

—JA

COBOLS AND ORANGES

After reading "COBOL Performs" by Ted Mirecki in your August 1985 issue (p. 107), I feel that the author makes several errors in his presentation and does not have a feel for the microcomputer market. These errors divide into two classes: improper comparisons, coupled with inadequate testing, and lack of understanding of what microcomputers are capable of performing.

The author made an apples-and-oranges comparison of mbp COBOL 7.0 with the latest versions of REALIA COBOL, Microsoft COBOL, and Micro Focus COBOL, all of which came out after version 9.0 of the mpb product.

Speed comparisons made by the author were largely meaningless because the 1,000- and 1,500-line programs are too small to give a true test of relative speeds. Both Ryan-McFarland COBOL and Microsoft COBOL slow down after about 2,500 lines of code. In fact, mbp actually will compile the larger programs faster than RM.

On the second point, Mr. Mirecki apparently believes the microcomputer is little more than a toy and envisions the user with two floppy disks. This is not in accord with the facts if the article really meant to cover "serious business uses." I have never heard of an accounting program of any consequence that runs satisfactorily on two floppy disks, in lieu of a hard disk. These programs also require a hard disk for development. In addition, the author did not give any attention to multiuser considerations. Because most serious micros used in business will probably be used in a multiuser environment, this omission is serious.

Micro Focus COBOL boasts two products, ANIMATOR and FORMS, which are not of much use in development. ANIMATOR, while ingenious, is not needed to develop programs. This debugging utility is most useful in checking out poorly designed programs. It is my feeling that the remedy is to design programs with more structure and modularity rather than embalming bad practices. We look for errors by examining source code; it takes less than 10 minutes.

The FORMS program is of little use on our dynamic screens. Tests of this program indicated that FORMS works best on static, simple screens. When dynamic screens are used, the program becomes cumbersome.

Our evaluation of Micro Focus indicates it has one important omission making it generally unsuitable for interactive programs on a microcomputer. According to information from the company, its compiler lacks an UPDATE command or routine. This routine allows a single-key acceptance of unchanged data in a field, without retyping. It is used continually by the operator and its omission is a serious problem. This is not a problem on a mainframe or a minicomputer where batch processing is the rule, but it is fatal for interactive programming.

Most COBOL articles in the microcomputer press have been written by someone who hates COBOL and who probably has never written a line of code in the language. It is refreshing to read an article by an author who obviously understands COBOL. Next time, get someone with a micro background.

Gordon R. Page
Vice President
Real-time Accounting, Inc.
Gladwyne, PA

This is the first time I have been accused of considering the microcomputer a toy. Most of the time, I am accused of considering the mainframe an outdated dinosaur. The truth lies somewhere in between. To address each of Mr. Pages' points in turn:

I did not make comparisons to mbp COBOL version 7; the tables and the text specifically refer to version 9. As was noted in the last installment of the series, the evaluation of mbp COBOL was deferred until this latest version became available. According to the release date supplied by mbp, it was the most recent of the COBOLs reviewed.

The sizes of the test programs were chosen in this range because I am philosophically opposed to programs longer than 2,000 lines. COBOL programmers may gasp in disbelief, but I have found that it is possible to write commercially useful programs of this length. Yes, I could have compiled longer programs downloaded from a mainframe, but the nontrivial ones were either interactive, making use of CICS and IMS calls not supported on a micro, or batch oriented, not of the type useful in the micro environment.

If Mr. Page infers that I do not know his segment of the microcomputer market, then I plead guilty. But there is more than one microcomputer market. According to some reports, the majority of microcomputers are not equipped with hard disks and are not networked. I know of many "kitchen table" software companies and of even more small businesses for which the purchase of any computer system, let alone multiple hard-disk systems, is a major expenditure. Somehow, it seems that the use of a single dual-floppy-disk microcomputer by a small business is more "serious" (to the business, if not to the installer) than the use of a network of hundreds by a Fortune 500 company.

Mr. Page is certainly entitled to his opinion that the ANIMATOR and FORMS utilities are useless. FORMS, like any automated programming aid, becomes cumbersome at the limit. It is easy to say that well-designed programs do not need debuggers—because they do not have bugs; but in the meantime, let's consider how many mortal programmers prefer scanning the source code to using interactive debuggers.

It's quite true that Micro Focus COBOL does not have an UPDATE function to indicate the accepting of the current contents of a screen field without changes. It does not need one. This capability is inherent in the screen handling built into the language, as is amply demonstrated by the example program included with the compiler.

In the conclusion of the COBOL series, I pointed out that the final evaluation of a compiler must be made by the user who must live with it. This left open the possibility of conclusions different than my own. I do not question the expertise of anyone who prefers a product that is not my favorite.

—Ted Mirecki

HE FOUND ANOTHER FIND

Although the article "A Good Find" by Mark Ackerman (October 1985, p. 85) and the supporting program are great, Mr. Ackerman's statement, "...DOS has no facility for finding such a file..." bothered me. Perhaps Microsoft's intent of the following DOS commands were not as I have presented them, but they accomplish the job.

To obtain directory information:

```
chkdsk [d:]/v|find "UPPER_CASE_STRING"
```

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As examples using the default drive

chkdsk/v|find "AUBURN.LTR"

will display all CHKDSK output lines containing AUBURN.LTR, and

chkdsk/v|find "AUBURN"

will display all lines containing AUBURN. For searching a particular directory, use:

chkdsk/v|find "\LETTERS\AUBURN"

However, searching for all files with extension .ltr within the directory letters requires an addition pipe, as in:

chkdsk/v|find "LETTERS\"|find ".LTR"

William E. Smith
San Diego, CA

Thank you for your clever suggestion. Obviously, these commands are useful, and are good candidates for batch files. We ran Mr. Ackerman's program because it automates the process and performs the search as fast as possible.
—WF

FORTRAN EXCHANGES

I read with interest the article titled "FORTRAN Options" by Alan Howard in the October 1985 issue (p. 149). We have used all four of these compilers and came to approximately the same conclusions, but differ in detail, perhaps due to differences in versions.

We obtained our Professional FORTRAN compiler, version 1.1, from Ryan-McFarland. (I don't know how RM version numbers correspond to those assigned by IBM.) It has two runtime libraries, not one. If Mr. Howard had run larger benchmark programs (more code, not more memory or time), he might have discovered that Professional FORTRAN frequently reports "error 8003 Internal Compiler Error: The compiler has detected an internal inconsistency in its data. This should not occur..." When it works, the RM FORTRAN compiler produces the fastest and smallest code of the four reviewed, but it isn't much use to us because it won't compile our programs. We agree that RM's debugger is excellent.

The DRI FORTRAN compiler was too full of bugs to be useful, and DRI was unwilling to provide errata lists that would have assisted work-arounds.

As Mr. Howard mentioned, Microsoft FORTRAN compiles only the subset standard, which for many applications is substandard. We don't use it unless a customer insists.

We use the Lahey FORTRAN compiler almost exclusively for several reasons: It runs faster by far than any of the others. It doesn't seem to have nearly as many bugs, and when we discover a bug, Lahey Computer Systems is very responsive. We did not find it necessary to tell the linker to include the Lahey runtime executive F77L.OBJ first. Otherwise, we agree with Mr. Howard.

We applaud the author's early attention to transportability and his recognition that FORTRAN is the only serious vehicle for it. But we wonder at his sincerity when he advocates allowing extensions that both violate the standard and invite portability problems. In particular, the equivalence (explicitly or via common) of character and noncharacter data types makes it impossible to transport codes between machines that do not have the same word length. Some machines don't have 16- or 32-bit words —the UNIVAC 1100 and Honeywell 6000 have 36-bit words; CDC 6000/7000/Cyber machines have 60-bit words. We believe portability is possible only by adherence to the standard. Language extensions are nice, but the compiler should diagnose their use unless directed otherwise. (The compiler *must* diagnose them if it is to conform to

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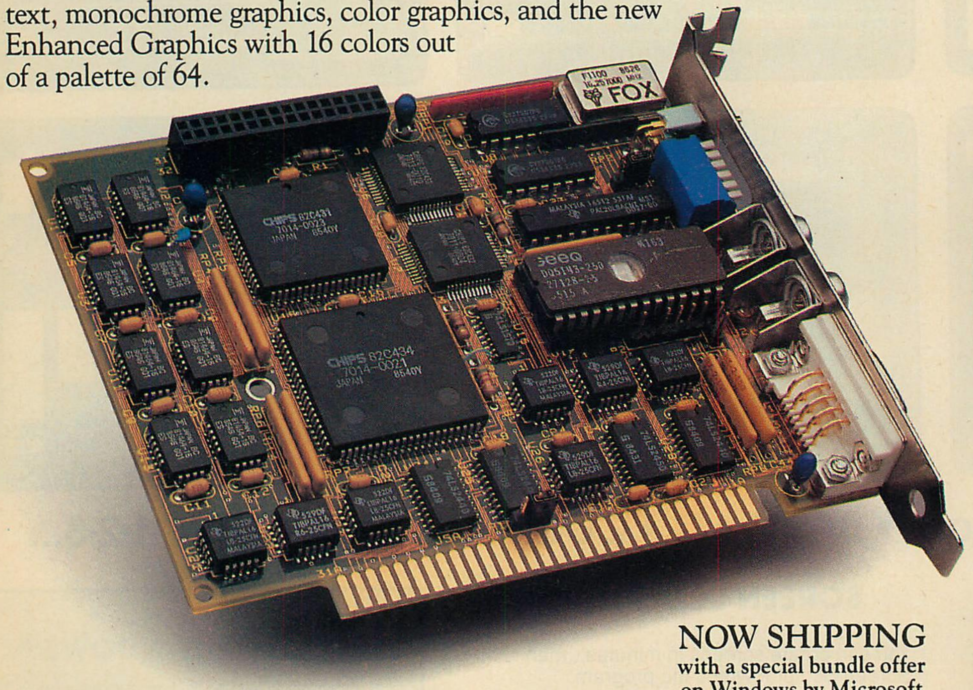

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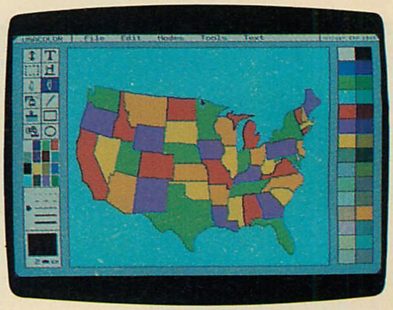

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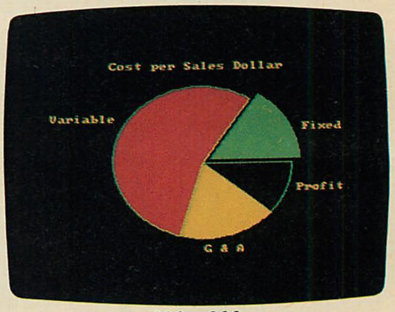

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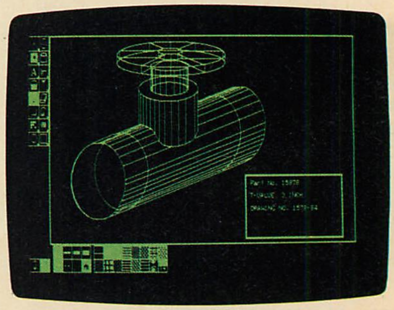

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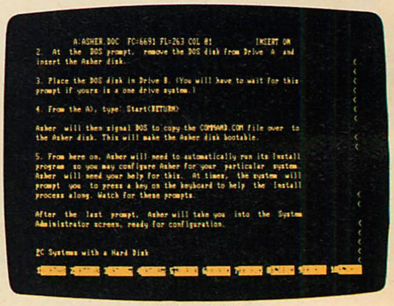

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Federal Information Processing Standard 69, in which conformity is legally, but not practically, necessary if the compiler is to be used by the federal government directly or under contract.)

The remarks about file size in connection with the pentathlon benchmark program are misleading. The extra information in the files to support FORTRAN BACKSPACE statements are necessary in any case because the RECL= specification in the OPEN statement can be used only with the ACCESS='DIRECT' specification (see page 12-20, lines 14-16 of the standard).

His remarks also may indicate some uncertainty in program design. If the file size is "two to five times the expected 15,000 bytes," then he must have written one-byte records. One of the most elementary techniques to improve performance of I/O-bound programs is blocking of several records into one before transferring the data. This technique was first used with magnetic tape to overcome start-stop delays, where it also resulted in using less tape because of the absence of inter-record gaps. But it is equally applicable to disk to avoid rotational latency delays, and, in this instance, to reduce the space required for record framing.

W. Van Snyder
Jet Propulsion Laboratory
Pasadena, CA

The compiler error 8003 in the IBM compiler was covered in the article. Because it only appeared once in my testing I chose not to make a big issue of it. Each of the compilers tested failed at least once. It is disturbing to learn that this particular error is more widespread than I observed.

Whether F77L.OBJ must be placed first in the link command is a small point; the main point is that it must be included. The examples and directions that appear in the documentation all indicate that it should be first.

Portability is a serious concern, but then so is getting a system implemented. There is at least one FORTRAN program that has files that include both numeric and character data. The trade-offs between portability and usable implementation must be weighed carefully as part of the system design.

The reader notes that the file used for the pentathlon is comprised of one-character records. As explained in the text, the choice of using single-character records was based on the structure of the pentathlon program in the review of the C compilers. The listing that was

provided of the pentathlon program is also a clear indication that single-character records are used. I would note that the following sentence hit the editing room floor: "The file copy test is included for completeness because most FORTRAN files are not organized as a series of one-byte records."

—Alan Howard

Thank you for reviewing F77L version 1.1, Lahey Computer Systems' implementation of the FORTRAN 77 standard. We would like to make the following corrections and comments.

There is an error in table 1 under CHARACTER*n: F77L CHARACTER length may be as large as 65,519, not 16,383.

Since version 1.1 (last shipped during March 1985), LCS has made many improvements to F77L, including an expanded manual that we are shipping with version 1.36, our current release.

Our version 2.0 includes the ability to address arrays and/or commons larger than 64KB, as well as faster, smaller generated code and the completed Source On-Line Debugger (SOLD) package. SOLD displays the FORTRAN source code while tracing and allow displaying, modifying, and monitoring the changing of variables and array elements (by name, not address) without recompiling and relinking.

We have noted that F77L executed faster in 6 of the 14 tests and the total execution time for IBM was 529.62 seconds compared to Lahey's 303.40—43 percent faster overall.

Finally, we were disappointed that the review did not include testing a production program of meaningful size. We are certain that our fast compile speed (users report four to seven times faster than IBM/RM on medium and large programs), mainframe extensions, and excellent diagnostic messages would have impressed the reviewer as much as they impress our users. They report that compile speed is more significant on a personal computer than it is on a mainframe.

Thank you again for helping more people find out about F77L.

Thomas M. Lahey
President
Lahey Computer Systems, Inc.

The error in table 1 is mine. As Mr. Lahey states, character variables may be up to 65,519 characters in length; 16,383 is the maximum length of a character constant in a data statement. While his claim of being 43 percent faster than the IBM/RM compiler on the tests may be true, I think it is a misleading statistic and cannot be used to make a general conclusion. I had hoped to include results of larger programs; however, the effort to put any of the larger programs into a form compatible with all four compilers was well beyond the scope of this review.

—Alan Howard

In converting a very large mainframe FORTRAN program to the IBM PC, I have been living for more than a year with some of the compilers Alan Howard reviewed. I would therefore like to add my observations to his.

I have found two disturbing features of the IBM compiler (I have been using the Ryan-McFarland incarnation). One is that the following construction

```
OPEN(UNIT=IFILE,FILE=FNAME,
  STATUS='OLD')
  CLOSE(UNIT=IFILE,
  STATUS='DELETE')
```

will not delete an existing file. Inserting an ENDFILE IFILE statement between these two lines will solve the problem.

The other feature is that writing a long unformatted record on a file will abort with an error message, *unless* you call the executable file with a command line parameter R /n where *n* is the number of bytes you want to write, clearly an absolute nuisance.

With the IBM FORTRAN a carriage return is *not* inserted at the end of a formatted write, but if followed by another formatted write, a blank line will appear in between, *unless* a plus sign (+) is coded as the first character in the second FORMAT statement. This is also a nuisance and can cause serious problems whether or not you have data printed by the program in between. I will take the Microsoft approach of an extra character (which is, incidentally, the backslash, not the dollar sign) to suppress carriage returns.

With the Microsoft compiler, on the other hand, I had a crazy abort with a message about the stack full or the heap invalid that was never resolved, but magically disappeared when I switched from version 3.2 to 3.3.

Dr. George Szentirmai
Santa Clara, CA

Dr. Szentirmai's comment on file delete is true for IBM FORTRAN compiler; the others work correctly. The problem he points out on carriage return control is, again, my error.

—Alan Howard

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Turbo PASCAL	70	49
Turbo DATABASE TOOLBOX	55	49
Turbo EDITOR TOOLBOX ... *New*	70	59
Turbo GAMEWORKS TOOLBOX ... *New*	70	59
Turbo GRAPHIX TOOLBOX	55	49
Turbo TUTOR	35	29
Turbo Holiday Pack ... *Turbo PASCAL/Database/Tutor*	125	99
Turbo New Pack ... *Editor/Gameworks*	95	79
Turbo POWER TOOLS by Blaise Computing	100	89
TurboPower Utilities by TurboPower Software	95	89
TurboRef by Gracon Services	50	45
TurboWindow by MetaGraphics	50	39
XTC *Text Editor* by Wendin	99	89

wendin products

	LIST	OURS
Operating System Toolbox ... *Build your own OS*	99	89
PCUNIX *Operating System*	99	89
PCVMS *Operating System* ... *Similar to VAX/VMS*	99	89
XTC *Text Editor* ... *Includes Pascal source code*	99	89

xenix system v by sco

	LIST	OURS
Xenix 86 Development System ... *For XT*	495	449
Xenix 86 Operating System ... *For XT*	495	449
Xenix 86 Text Processing Package ... *For XT*	195	179
Complete Xenix 86 System ... *Combined Package*	1085	969
Xenix 286 Development System ... *For AT*	495	449
Xenix 286 Operating System ... *For AT*	495	449
Xenix 286 Text Processing Package ... *For AT*	195	179
Complete Xenix 286 System ... *Combined Package*	1085	969

xenix languages and utilities

	LIST	OURS
APL*PLUS/UNX System by STSC ... *For AT only*	995	795
Btrieve by SoftCraft	595	469
c-tree by FairCom	395	329
Microsoft BASIC Interpreter	350	279
Microsoft COBOL Compiler	995	795
Microsoft Fortran Compiler	495	389
Microsoft PASCAL Compiler	495	389
PANEL *Screen Designer* by Roundhill ... *For AT only*	595	539
Windows for C by Vermont Creative Software	395	359
Windows for Data by Vermont Creative Software	595	539

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programmer's connection

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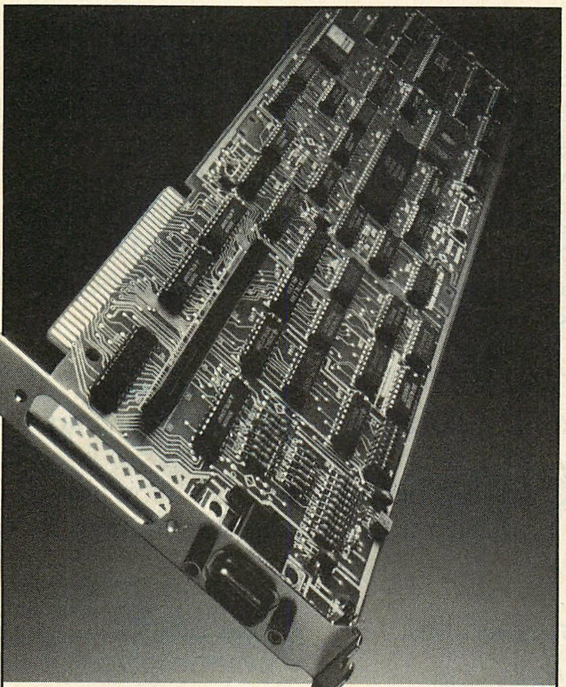
CIRCLE NO. 175 ON READER SERVICE CARD

And some good news.



The Paradise Modular Graphics Card runs all the popular programs Hercules does, plus 150 more.

For $395, the Paradise Modular Graphics Card runs all these programs. In monochrome. And in color.

Arrays/Continental Software, *Ultra File*
Ashton-Tate, *Framework*
BPS, *Overhead Express*
Brightbill-Robert, *Graphix Partner*
Chang Labs, *GraphPlan*
Dow Jones & Co., *Dow Jones Market Analysis*
Lotus Development, *1-2-3, Symphony*
MicroPro, *Chartstar, Planstar*
MDBS, *Knowledge Manager*
MicroSoft, *Basic Compiler, Basic Interpreter, Chart, Flight Simulator, Project, Word*
PC Software of San Diego, *Executive Picture Show*
Prentice-Hall, *Execuvision*
Schuchardt Software Systems, *Intecalc, Intemate, Intepert, Inteplan, Inteword*
Softrend, *Aura*
Software Products Int., *Open Access*
Software Publishing, *PFS:Graph*
Sorcim, *SuperCalc 3*
Summa Software, *Winning On Wall Street: Trader's Forecast, Winning On Wall Street: Trader's Data Manager*
Advanced Ideas, *The Game Show, Master Match, Tic Tac Show*
CBS Software, *Big Bird's Special Delivery, Dinosaur Dig, Ernie's Magic Shapes*
Davidson & Associates, *Math Blaster!, Word Attack!*
Designware, *The Grammar Examiner, Math Maze, Language Arts, Spellicopter, States & Traits, Trap-a-zoid*
Developmental Learning Materials, *Alien Addition, Alligator Mix, Demolition, Division, Dragon Mix, Meteor Multiplication, Minus Mission*
Eduware, *Algebra 1, Algebra 2, Algebra 3, Algebra 4, Algebra 5*
Individual Software, *Professor Pixel, The Instructor, The Typing Instructor*
Knoware, *Knoware*
Scarborough Systems, *Mastertype, Songwriter*
Learning Co., *Addition Magician, Magic Spells, Moptown Parade, Number Stomper, Reader Rabbit*
Scholastic, *Turtle Tracks*
Sierra On-Line, *Dragon's Keep, Troll's Take*
Simon & Schuster, *Typing Tutor III*
Spinnaker Software, *Alphabet Zoo, Delta Drawing, Fraction Fever, Hey Diddle Diddle, Kids on Keys, Kindercomp, Rhymes & Riddles, Story Machine*
Springboard, *Early Games for Young Children, Make a Match, Piece of Cake Match, Quizagon*
Thoroughbred Software, *Exploring the Amazing Food Factory, The Fascinating Story of Cell Growth, How Plants Grow, Migrating Molecules, Mastering Units of Measurement, Photosynthesis*
Unicorn Software, *Funbunch, Ships Ahoy, Ten Little Robots*
Digital Research, *DR Logo*
Energtonics, *Energraphics*
Fox & Geller, *dGraph, OZ*
Graphic Communication, *Graphwriter BASIC, Graphwriter Combination, Graphwriter Extension*
Harvard Associates, *P.C. Logo*
Innovative Software, *Fast Graphs*
Mouse Systems, *PC Paint*
PC Software of San Diego, *PC Crayon*
Peachtree Software, *Business Graphics System*
Arktronics, *Jane*
Eagle Software Publishing, *Personal Financier*
Monogram, *Dollars and $ense*
Penguin Software, *Graphics Magician*
Sierra On-Line, *Homeword*
Adventure Enterprises, *Sea Dragon*
Atarisoft, *Centipede, Defender, Dig Dug, Donkey Kong, Pac Man, Robotron, Stargate*
Avalon Hill Game Company, *Andromeda Conquest, Computer Football Strategy, Computer Stocks & Bonds, V.C., Voyager*
Broderbund Software, *Serpentine*
CBS Software, *Match-Wits, Mystery Master: Murder by the Dozen*
Hayden Software, *Sargon III*
Innovative Design Software, *Pool 1.5*
Intelligent Statements, *Asylum*
Microlab, *Crisis Mountain, Death in the Caribbean, Dino Eggs, High Rise, Miner 2049er*
Muse Software, *Castle Wolfestein*
Odesta, *Backgammon, Checkers, Chess, Odin*
Origin Systems, *Ultima III*
Orion Software, *J-Bird*
PC Software of San Diego, *Championship Blackjack*
Penguin Software, *The Quest*
Priority Software, *Forbidden Quest*
Scarborough Systems, *Buck Rogers, Congo Bongo, Star Trek*
Sentinent Software, *Cyborg*
Sierra On-Line, *BC's Quest of Tires, Championship Boxing, CrossFire, Dark Crystal, Frogger, King's Quest, Oil Well, Ultima II, Ulysses and the Golden Fleece*
Sir Tech, *Wizardry*
Sirius Software, *Buzzard Bait*
Spectrum Holobyte, *Gato*
Spinnaker Software, *Snooper Troops #1, Snooper #2*
Sublogic, *"Night Mission" Pinball*

It's true, Hercules only runs 10 of the 161 programs with graphics for the IBM PC carried by SOFTSEL®, the largest distributor of micro computer products.

Since the Paradise Modular Graphics card is 100% compatible with the IBM color graphics standard, it'll run virtually every program written for the PC. In monochrome. And in color. Now and in the future.

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SYSTEMS, INC

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MICROSOFT LANGUAGES NEWSLETTER Vol. 1-2

News about the Microsoft Language Family

New Microsoft® LISP Offers a Complete LISP Programming Environment

Microsoft has extended its six-year relationship with Soft Warehouse, Inc. of Hawaii by renewing the licensing agreements for muLISP™ and muMATH™ products. Microsoft LISP, the newly updated release of Microsoft muLISP, is the most powerful LISP development environment available for MS-DOS® today. Not only is Microsoft LISP three times faster than its competitors, it also allows larger artificial intelligence programs and expert systems to be developed. The new LISP provides over 400 Common LISP functions, macros, special forms, and control variables. Microsoft LISP comes with an integrated window-oriented LISP editor and debugger, tutorial lessons, and several demonstration LISP programs.

Mixed Memory Model Dynamic Allocation in Microsoft C—Part 1

The standard method of dynamic heap allocation in C is provided by the *malloc* and *free* library routines. In Microsoft C this has been extended to allow mixed memory model dynamic allocation and deallocation in both *near* and *far* heaps for all memory models by using the undocumented routines below:

```
extern char near* _nmalloc(unsigned int);    /*near heap*/
extern void _nfree(char near*);              /*near heap*/
extern char far* _fmalloc(unsigned int);     /*far heap*/
extern void _ffree(char far*);               /*far heap*/
```

For example, a small memory model C program can be written that can dynamically allocate and access more than 64K of data by using far heap allocation and far pointers. Similarly, the efficiency of large model programs can be improved by using near pointers and the near heap. However, with mixed model programming, care must be taken when accessing library routines that take pointers for parameters.

Part II to follow next month.

Microrim's R:BASE™ 5000 Developed in Microsoft FORTRAN and C

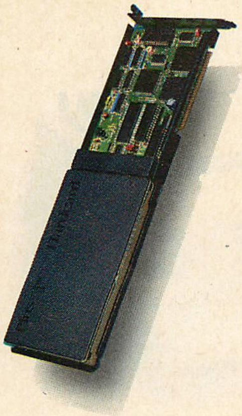
The core R:BASE 5000 database management system product contains about 40,000 lines of Microsoft FORTRAN code. New modules for R:BASE were developed in Microsoft C. Fred Gray, Microrim's Director of Development said, "Interlanguage calling allows us to migrate our code from FORTRAN to C without having to rewrite the entire product at once."

Microrim also provides the R:BASE Program Interface,which is a library of relocatable FORTRAN routines for accessing R:BASE databases. The interlanguage calling support in Microsoft FORTRAN, Pascal, and C allows application developers to call any routine in the Program Interface.

Write to: MICROSOFT Languages Newsletter
10700 Northup Way, Box 97200
Bellevue, WA 98009 for product and update information
Or phone:
(800) 426-9400. In Washington State and Alaska, call (206) 828-8088. In Canada, call (800) 387-6616.

Latest DOS Versions:

Microsoft C	3.00
Microsoft COBOL	2.10
Microsoft FORTRAN	3.31
Microsoft Macro Assembler	4.00
Microsoft Pascal	3.31
Microsoft QuickBASIC	1.00



The Hardcard

By assuming connection to the IBM PC, this hard-disk-on-a-card offers exceptional speed, reliability, and ease of use.

The 10MB hard disk, once a great luxury, is rapidly becoming a minimum requirement for serious use of the IBM PC. Important new software products, such as Microsoft Windows, can be installed on floppy disks, but they leave little room for anything else. Microtec's Professional Pascal compiler, for example, is a 566KB .EXE file—larger than a single 360KB floppy diskette. In the coming years, attention will be focused on the system with the hard disk.

Adding a hard disk to the PC is not a trivial matter. One floppy-disk drive must be removed (and replaced by the hard-disk drive), and two data cables must be run and connected to a controller board that must be installed in a vacant slot. Typically the PC's 63.5-watt power supply must be enhanced or replaced by a more potent supply. In addition, the user often is unwilling to forgo dual-floppy-drive convenience and so replaces the remaining full-height floppy-disk drive with a pair of half-height drives. These changes leave the user with a lot to buy, a lot to do, and, more importantly, a lot that can go wrong. Given the available components, however, this would seem to be the simplest method.

The only easier method would be to build a hard disk onto a PC bus expansion card, but that's impossible—or so it appeared before the midsummer 1985 announcement of Plus Development's Hardcard. No one had expected this product, and for a long time no one believed that a shock-resistant hard-disk system could be made only 1⅛ inches thick. Plus, however, delivers a product that is everything it claims to be and more. For this reason, *PC Tech Journal* has named the Hardcard as its February 1986 Product of the Month.

The Hardcard is as ambitious a piece of design work as the PC itself was conservative. Half of the device's 20 ICs are custom-designed, surface-mounted chips on an extremely dense board layout. The layout precludes the use of traditional discrete bypass capacitors and requires the tiny leadless surface-mounted chip variety instead.

The drive mechanism is a wonder of mechanical compaction. It is an entirely new design; little has been borrowed from traditional hard disks. Apart from being small, fast, and simple, it is also rugged, capable of withstanding shocks of 100 g without damage. The read/write heads automatically park themselves and lock into a protected position when power is removed, a further precautionary feature. The reliability figure quoted for the Hardcard is a new high for hard-disk subsystems: an MTBF of 25,000 hours.

PRODUCT NAME
Hardcard
COMPANY
Plus Development Corporation
ADDRESS
1778 McCarthy Boulevard
Milpitas, CA 95035
TELEPHONE
408/946-3700
PRICE
$1,095

But good design is only one factor; the use of considerably fewer parts accounts for more. The Hardcard can reduce the number so drastically partly because the function of what might have been a hundred ICs has been combined into a handful of custom LSI chips. Furthermore, Hardcard dispenses with a great deal of the hardware overhead of a standard hard-disk interface.

To accommodate widely varied host computer requirements, typical hard-disk units must present a standard interface to the outside world. This interface must be able to pass signals reliably at great speed over long cables through noisy environments. The controller board must have matching machinery to communicate with the hard disk itself. The Hardcard does away with the standard interface and assumes that it always will be connected to one standard, well-known bus: the IBM PC bus. Eliminating noisy paths and unnecessary components cannot help but produce a more reliable device.

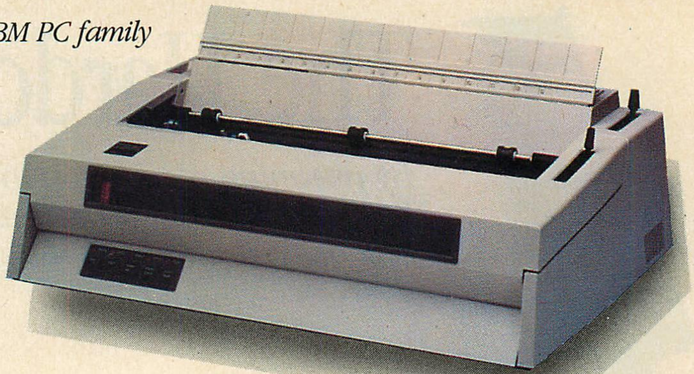
By assuming connection to the IBM PC, the Hardcard disk can be formatted at the factory to a standard DOS format, eliminating one installation step and a possible source of user confusion and error. Its pervasive reliance on the standard set for the PC is a factor in the Hardcard's success as a piece of engineering. The PC standard itself may not be brilliant, but it is a standard that is thoroughly understood, well documented (thanks largely to IBM's open-architecture policy), and represented in the field by millions of PCs and close compatibles.

Plus Development's commitment of a major piece of ground-up development work in mass storage to a single computer is quite a leap of faith. The Hardcard is the first mass-storage peripheral that cannot be installed on different computer architectures. Risk is involved in any such commitment, but the dividends in reliability and ease of installation are considerable.

However, the premium exacted for this convenience and reliability—$1,095—is too high for 10MB. As similar products appear with off-the-shelf standard interfaces, the competition may help to bring its price down. However, their economies of complexity, reliability, and size will not be as great as Hardcard's; further, Plus's innovative optimization about the IBM PC standard will give it an edge for some time. (The Hardcard is reviewed in more detail in this issue of *PC Tech Journal*; see "Storage on a Card," Thomas V. Hoffmann, p. 139.)

Hardware, software, and other developments for the IBM PC family

Anchor Automation's 1200-bps modem



IBM Wheelprinter E

FROM IBM

The **IBM PC Voice Communications Option** consists of an adapter card and control program that, combined with applications software, give PC users new voice and telephone management capabilities. Software is available to control applications by voice command, to create and store personal telephone directories, to use the PC for automatic dialing, to play back telephone messages via the PC, to convert text to synthetic speech, and to gain access to mail and calendar information. $1,250.

Also from IBM, the **Personal Telephone Manager** connects a PC to a telephone and allows users to create and store personal telephone directories. With a single keystroke, the user can instruct the PC to dial a directory number. The package consists of an adapter card and an application program. Adapter, $325; program, $70.

Electrophotographic technology allows the **IBM Pageprinter** to print text and graphics at speeds of 12 pages a minute. The Pageprinter attaches to most PCs and can be used as a text-only printer for the IBM System/38 and two models of the System/36. It also can serve as a full-function text and graphics printer with larger systems and, with an optional sharing card, can be attached to eight PCs in a single office and to all the systems connected on a LAN. $7,490.

The **IBM Wheelprinter E**, uses a cartridge print wheel to produce letter-quality text on correspondence and multipart forms. It is designed for both home and office use. $699.

In addition, the company's new **DisplayWrite 3 version 1.1** allows more efficient exchange of information with other IBM systems, such as the System/36. It gives users greater capabilities for converting DisplayWrite 3 text to and from revisable-form text and to final-form text. $450.

Rolm Corporation, an IBM company, has announced **Juniper II**, an integrated voice/data communications complement to the PC, PC/XT, and PC/AT, that provides compatibility with IBM's Personal Services/PC and PROFS/PC Connection, which are PC-resident communication packages. Juniper II allows PC users to transfer information to and from a host computer or another PC at speeds of up to 9600 bps. Other features include: IBM 3270 and DEC VT100 terminal emulation capabilities; one-touch log on for data calls; two-way speakerphone; and powerful digital telephone functionality. The package consists of a multifeatured digital telephone, an adapter card, connector cabling, and software. $1,295.

Also from Rolm comes the **3270 CTPA (coax-to-twisted-pair adapter)** that allows IBM 3270 terminals to be connected to control units using telephone twisted-pair wiring. Customers now have the option of using previously installed telephone wire to connect terminals. $100 per connection.

IBM Corp., Information Systems Group, Rye Brook, NY 10573; Contact the local IBM dealer, 800/426-2468

CIRCLE 319 ON READER SERVICE CARD

Another group of products from **IBM**, collectively called **A Realtime Interface Co-Processor (ARTIC)**, enhances the processing capabilities of industrial computers in a manufacturing environment. ARTIC includes a coprocessor with 128KB of user memory, a control program that supports concurrent processing of as many as 253 tasks, DOS support, a communications subsystem that provides a link between applications programs and terminal devices controlled by communications tasks, and a developer's kit.

IBM Corp., Manufacturing Systems Products, Boca Raton, FL 33432; Contact the local IBM dealer, 800/426-2468

CIRCLE 320 ON READER SERVICE CARD

IBM also has announced price increases on 139 of its more than 475 programs for the PC family. Most of the increases, based on single-unit prices, are between 8 and 10 percent. Software affected includes operating systems, and educational, entertainment, and business programs. Among those not affected are the firm's Personally Developed Software and most of the Assistant, Personal Decision, and Business Management Series.

IBM Corp., Entry Systems Division, Boca Raton, FL 33432; Contact the local dealer, 800/426-2468

CIRCLE 321 ON READER SERVICE CARD

HARDWARE

The Signalman Secure 12 is an intelligent 1200-bps modem with a built-in security callback system. Introduced by **Anchor Automation, Inc.**, the Secure 12 can operate as either a secure or a standard modem and conforms to the Hayes command structure, which allows both unattended and manual data transmission from virtually any external computer or terminal. $499.

Anchor Automation, Inc., 6913 Valjean Avenue, Van Nuys, CA 91406; 818/997-7758

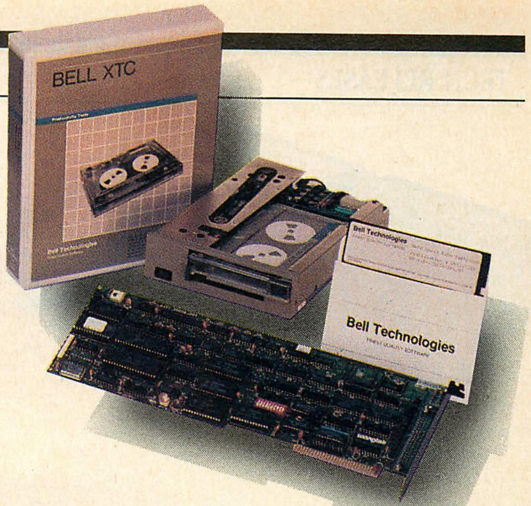
CIRCLE 325 ON READER SERVICE CARD

The **Persyst SuperCharger**, a combination high-speed 8086 microprocessor and 512KB high-speed 16-bit memory board, has been introduced by **Emulex Corporation**. The 8086 chip runs at either 9.54 mHz or 4.77 mHz; the speed can be selected by the user or by software. The memory board allows large spreadsheets and programs to load and operate quickly and reduces the processing time required for programs such as Lotus 1-2-3 and Symphony. $995.

Emulex Corp., 3545 Harbor Blvd., Costa Mesa, CA 92626; 800/EMULEX 3; in California, 714/662-5600

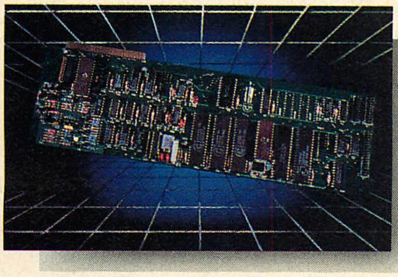
CIRCLE 327 ON READER SERVICE CARD

Quadram's 72MB internal hard-disk drive



XTC Tape Cartridge System

Adaptec, Inc. has announced the **ACB-2070A**, an encoding/decoding hard-disk controller board for the PC and PC/XT. The ACB-2070A plugs into a PC expansion slot or replaces the existing XT controller board and boosts disk-drive capacity by 50 percent. It provides 30MB of storage capacity in 20MB drives and supports an increased data-transfer rate of 7.5MB per second. The board's other features include automatic configuration, sector-level defect handling, large disk logical partitioning, and preprogrammed BIOS. $165.
Adaptec, Inc., 580 Cottonwood Drive, Milpitas, CA 95035; 408/946-8600
CIRCLE 336 ON READER SERVICE CARD



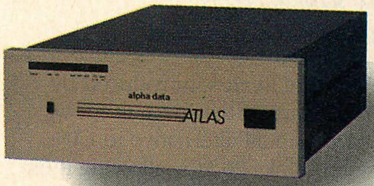
ACB-2070A by Adaptec, Inc.

A group of XENIX and UNIX hardware and software products for the PC/AT has been introduced by **Bell Technologies**. The **XTC Tape Cartridge System** provides 45MB or 60MB of high-speed tape backup for an AT with standard one-quarter-inch tape cartridges. The **B86**, an 86MB hard-disk drive, has an average access time of 28 milliseconds and formats disks to 72MB. It is fully compatible with the AT running DOS or XENIX, and users booting from the B86 can utliize the entire disk as a single volume. The new Bell **RAM2** card provides 2MB of RAM as well as an optional parallel and serial port capability on the same card. In addition, it offers parity checking across the entire memory range, and memory mapping is switch selectable. RAM2 uses 120 ns DRAM parts and is compatible with the **8MHZ System Clock Upgrade**, also new. This upgrade product includes a collection of four crystals that can replace the main system clock crystal on the AT and uses a special speed-selection process. XTC, $1,695; B86, $2,495; RAM2, $745; System Clock Upgrade, $45.
Bell Technologies, 44870 Osgood Road, Fremont, CA 94539; 415/659-9097
CIRCLE 323 ON READER SERVICE CARD

Quadram Corporation launched a new storage products division with the introduction of the **QuadDrive** line of full- and half-height hard-disk drives. Available in 10MB, 20MB, and 72MB versions for the PC and PC/XT, and in 20MB and 72MB versions for the PC/AT, the new drives are internal units that come with menu-driven software, a controller card, and complete documentation. For the PC or XT: 10MB, $945; 20MB, $1,195; 72MB, $3,995. For the AT: 20MB, $1,095; 72MB, $3,795.
Quadram Corporation, One Quad Way, Norcross, GA 30093; 404/923-6666
CIRCLE 322 ON READER SERVICE CARD

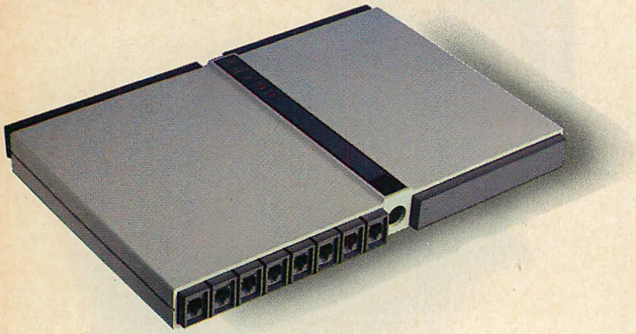
The **XP/48 Graphics Extension Processor** from **Superset, Inc.** provides the PC, PC/XT, and PC/AT with full 48-bit, virtual-memory mainframe graphics capabilities. This graphics system features 4,096-by-4,096 resolution (16.7 million simultaneous colors) and a library that includes bars, exploded pies, shaded fonts, three-dimensional surfaces and axes, shaded states and counties, world maps, log, polar, and calendar axes, grids, and spline and polynomial curves. Also included are full digitizer support, user-extendable publication-quality fonts, multipass rasterization with half toning, paneling and color separation, and drivers for more than 100 devices. $170,000.
Superset, Inc., 11025 Roselle Street, San Diego, CA 92121; 619/452-8665
CIRCLE 324 ON READER SERVICE CARD

ATLAS, a mass-storage, high-speed, disk-drive/disk-controller system, has been introduced by **Alpha Data Inc.** The system combines the Alpha Data 160MB disk-drive unit with the enlarged capacity Interphase Maverick controller board and appropriate software to provide 54 read/write heads on three disk-drive platters and instant access to 1MB of information in 18 milliseconds. 128MB system with Maverick, $10,850; 160MB system, $11,850.
Alpha Data Inc., 20750 Marilla Street, Chatsworth, CA 91311; 818/882-6500
CIRCLE 338 ON READER SERVICE CARD



ATLAS disk-drive/disk-controller system

Orchid Technology, Inc. announced a new line of multifunction boards that conform with the Lotus/Intel/Microsoft expanded memory specification. The boards feature high-capacity disk caching and print spooling. **ECCELL**, designed for the PC/AT, provides error-correction code capabilities, a total memory capacity of 12MB, and switchless installation. **Conquest** for the PC and PC/XT is a multifunction board, an expanded memory board, and an optional LAN adapter board. The third product is a compact board that is designed for installation in the short slot of the PC or the PC/XT. **CramRAM** is both a multifunction board and a memory board that provides 2MB of memory. ECCELL, $595; optional daughtercard, $145; Conquest, $395; CramRAM, $395.
Orchid Technology, Inc., 47790 Westinghouse Drive, Fremont, CA 94539; 415/490-8586
CIRCLE 326 ON READER SERVICE CARD



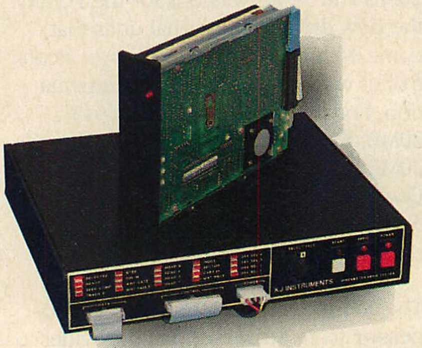
Alliance system by Matrix

Model 9000 Business Keyboard by Enigma

A new PC/AT compatible keyboard, the **Model 9000 Business Keyboard**, has been introduced by **Enigma Research, Inc.** Its features include: 40 user-programmable function keys; standard selectric layout with extra large Return and Shift keys; dedicated numeric keypad with a separate Return key, complete set of mathematical symbol keys, and separate control, Alt and Shift keys; LEDs on the CapsLock, NumLock, ScrollLock, and Print Echo On/Off keys; tactile feedback; and breakover feel. $295.
Enigma Research, Inc., 4534 Vista del Monte, Suite 104, Sherman Oaks, CA 91403; 818/784-0343
CIRCLE 330 ON READER SERVICE CARD

The **Alliance Series**, introduced by **Matrix Communications**, is a low-cost, easy-to-intall alternative to LANs. The system links 20 PCs, allowing them to share peripherals such as printers, modems, and disks. It is based on a programmable intelligent cluster controller that connects PCs via RS-232 interfaces at 115 Kbps, and offers the features of a LAN with asynchronous communications, such as file sharing, peripheral sharing, and a central clock and calendar. An additional 480KB buffer is available that allows the cluster controller to perform print spooling and electronic mail functions. Two software packages are included with the system: a utility program for administering the network and an interface program that allows each microcomputer to access the network. Eight-port model, $895; each additional four-port module, $349.
Matrix Communications, 112-116 Washington Street, Marblehead, MA 01945; 617/639-1211
CIRCLE 331 ON READER SERVICE CARD

A portable Winchester disk drive analyzer designated **Model 506** has been introduced as the first in a new line of technology test equipment from **KJ Instruments, Inc.** This analyzer allows test engineers to configure all test parameters in any sequence. Test programs can be entered and stored in nonvolatile memory, then selected for use with switches on the analyzer's front panel. In operation, it furnishes realtime test data on any ST506/412 compatible drive and tests fixed, removable, or fixed/removable Winchester models, including 5.25-, 3.9- and 3.5-inch units. Model 506 can operate by modem or extend to a network of eight test stations managed by one PC equipped with an eight-port RS-232 board. $3,500.
KJ Instruments, Inc., 22981 Alcalde Drive, Laguna Hills, CA 92653; 714/768-3070
CIRCLE 335 ON READER SERVICE CARD



KJ's Model 506 Winchester disk drive analyzer

A package that implements IBM's LU6.2 protocol has been announced by **Network Software Associates, Inc.** The **AdaptSNA LU6.2** lets a PC, PC/XT, or PC/AT communicate and transfer files in an IBM SNA/SDLC network. It supports PC-to-mainframe and PC-to-PC communications. AdaptSNA can be purchased as software only or as a package with a modem and SDLC interface hardware on a plug-in board. Software only, $795; package, $1,590.
Network Software Associates, Inc., 22982 Mill Creek, Laguna Hills, CA 92653; 714/768-4013
CIRCLE 339 ON READER SERVICE CARD

The result of a joint development program between **Texas Instruments** and **IBM**, the **TMS380** is a LAN adapter chip set. It provides standardized interfaces for attaching computers, terminals, telecommunications equipment, and other information processing devices to IBM's token-ring network. The TMS380 meets ANSI/IEEE specifications. It provides a 4 million-bps data rate when read over telephone twisted pair, shielded twisted pair, or fiber optics. The chip set includes three TMS380 chips, documentation, admission to a design workshop, and adapter tools. $1,985.
Texas Instruments, Semiconductor Group (SC-512), P.O. Box 809066, Dallas, TX 75380; 800/232-3200, ext. 700
CIRCLE 328 ON READER SERVICE CARD

Ungermann-Bass, Inc. has expanded its Net/One product line to include an implementation of the emerging office automation LAN standard token ring. Called **Net/One Token Ring**, it permits users to configure a 4 million-bps multiple-ring LAN system that includes server support for hosts, terminals, printers, and modems, workstation support for devices based on the Intel Multibus and the IBM PC bus, distributed wiring concentrator support, and network management. Network bridges allow nodes in different rings to communicate. Starter system, $47,750.
Ungermann-Bass, Inc., 2560 Mission College Blvd., Santa Clara, CA 95050; 408/496-0111
CIRCLE 329 ON READER SERVICE CARD

The **P2400-HC**, an addition to **Novation, Inc.**'s Professional Series modem line, runs at 2400 bps and uses only one-half of a slot in any PC. This modem uses surface-mount technology and can support error-correcting protocols and security features. $695.
Novation, Inc., 20409 Prairie Street, Chatsworth, CA 91311; 213/996-5060
CIRCLE 333 ON READER SERVICE CARD

SAVE OVER 30% ON OUR GIFT PACKS!
60-DAY MONEY-BACK GUARANTEE

How Borland's Three New Holiday Packs Will Fill Your Stocking Without Emptying Your Piggybank.

Three special packs with dazzling discounts that will help get you into a Holiday mood. You can get some of Turbo, most of Turbo, or all of Turbo—including the two newest members of the Turbo family, Turbo GameWorks™ and Turbo Editor Toolbox.™ You also get our unmatched 60-day money-back guarantee, quality products that aren't copy-protected.

TURBO NEW PACK $95.00.

You get the two exciting new members of the Turbo Pascal family,

- TURBO GAMEWORKS, Chess, Bridge, and Go-Moku, complete with source code and a 200-page manual.
- TURBO EDITOR TOOLBOX, all the building blocks to make your own editors and word processors, complete with source code and a 200-page manual.

TURBO HOLIDAY PACK $125.00.

You get all three of the Turbo family classics for only $125.00 (about a 30% discount). Turbo Pascal 3.0 and Turbo Tutor and Turbo Data-Base Toolbox—all for just $125.00.

- TURBO PASCAL combines the fastest Pascal compiler with an integrated development environment.
- TURBO TUTOR teaches you step-by-step how to use Turbo Pascal with commented source code for all program examples on diskette.
- TURBO DATABASE TOOLBOX offers three problem-solving modules for your Turbo Pascal programs: Turbo Access, Turbo Sort, and GINST, which generates a ready-to-run installation program that lets you forget about adapting your software to specific terminals.

TURBO HOLIDAY JUMBO PACK $245.00.

This is it—the whole thing, the entire Turbo family including its two newest members. You get:

- Turbo Pascal
- Turbo Graphix Toolbox
- Turbo Tutor
- Turbo DataBase Toolbox
- Turbo GameWorks
- Turbo Editor Toolbox

NEW!

and you pay only $245.00 for all six! Which means that you're getting everything at only about $40 a piece. Quite a holiday deal. (And if you already own one or several members of the Turbo family, be creative—nothing can stop you from buying the Jumbo Pack, picking out the ones you already have and giving the rest as holiday gifts to family and friends. At these prices you can afford to give to others and to yourself.) Speaking of Holidays, this offer lasts until March 31, 1986. (At Borland, we like to make the Holidays last.)

NEW!

TURBO GAMEWORKS $69.95.

Our new Turbo GameWorks offers games you can play and replay without Turbo Pascal or revise and rewrite with Turbo Pascal 3.0. We give you the source code, the manual, the diskettes and the competitive edge. Chess, Bridge and Go-Moku. State-of-the-art games that let you be player, referee, and rules committee all at once because you have the Turbo Pascal source code. Learn exactly how the games are made—so you can go off and make your own. And Turbo GameWorks is the only quality game you can buy that is not copy-protected. Sold separately, only $69.95. (Just $47.50 if you buy the Turbo New Pack.)

NEW!

TURBO EDITOR TOOLBOX $69.95.

Build your own word processor—for only $69.95! You get ready-to-compile source code, a full-featured WordStar™-like word processor, and a 200-page manual that tells you how to integrate the editor procedures and functions into your programs. With Turbo Editor Toolbox, you can have the best of all word processors. You can make WordStar behave like Multi-Mate. Support windows just like Microsoft's Word. And do it as fast as WordPerfect does it. Incorporate your new "hybrids" into your programs to achieve incredible control and power. Sold separately, only $69.95. (If you buy the Turbo New Pack, the price drops to just $47.50.

NOT COPY-PROTECTED

Holiday Gift Packs, Turbo GameWorks™ & Turbo Editor Toolbox™

Available at better dealers nationwide. Call (800) 556-2283 for the dealer nearest you. To order by Credit Card call (800) 255-8008, CA (800) 742-1133.

Make checks payable to: Borland International.

The holiday packs include an upgrade coupon for both options so you get BCD and 8087 support for $39.95 (regularly $55.00).

Carefully describe your computer system!

Mine is: — 8-bit — 16-bit

I use: — PC-DOS — MS-DOS — CP/M-80 — CP/M-86

My computer's name and model is: ______

The disk size I use is: ☐ 3½" ☐ 5¼" ☐ 8"

Name: ______

Shipping Address: ______

City: ______

State: ______ Zip: ______

Telephone: ______

NOTE: Turbo Editor Toolbox and Turbo GameWorks are available for the IBM PC and true-compatibles using Turbo Pascal 3.0 ONLY.

*Gift Pack Offers Last Until March 31, 1986

		Quantity
*Turbo Holiday Jumbo Pack	$245.00	___
*Turbo Holiday Pack	$125.00	___
*Turbo New Pack	$95.00	___
Pascal	$69.95	___
Pascal w/8087	$109.90	___
Pascal w/BCD	$109.90	___
Pascal w/8087 and BCD	$124.95	___
Turbo DataBase	$54.95	___
Turbo Graphix	$54.95	___
Turbo Tutor	$34.95	___
Turbo Editor	$69.95	___
Turbo GameWorks	$69.95	___

These prices include shipping to all U.S. cities. All foreign orders add $10 per product ordered.

Amount: (CA add 6% tax) ______

Payment: VISA MC Check Bank Draft

Credit Card Expiration Date: ___ / ___

Card # ______

COD's and Purchase Orders will not be accepted by Borland International. California residents: add 6% sales tax. Outside USA: add $10 and make payment by bank draft, payable in U.S. dollars drawn on a U.S. bank. H6

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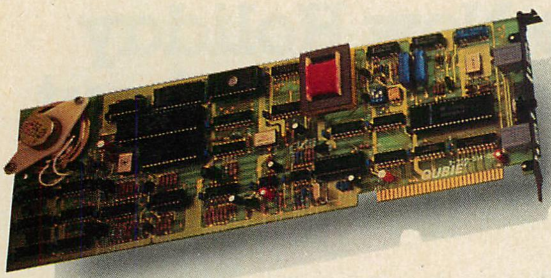
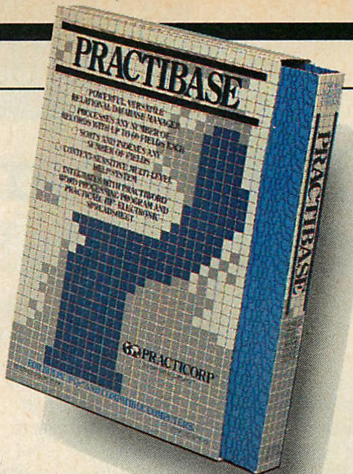
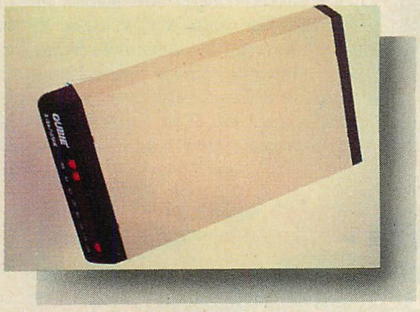


PC212A/1200 internal modem by Qubie'



PractiCorp's new database

The **PC212A/1200** internal modem and the **PC212A/1200E** external modem from **Qubie'** combine a 300-baud chip with a 1200-baud chip to produce 103/212A compatible modems. This design results in lower manufacturing costs, increased reliability, and better communications over marginal-quality telephone lines. Both models are compatible with Hayes modems. PC212A/1200, $179; PC212A/1200E, $199.
Qubie', 4809 Calle Alto, Camarillo, CA 93010; 800/821-4479; in California, 805/987-9741
CIRCLE 334 ON READER SERVICE CARD



Qubie' PC212A/1200E external modem

Debugging support for software developers writing code for the PC/AT running in protected mode is available from **Atron**. This software debugger runs on **AT PROBE**, a hardware-assisted debugging tool that plugs into the PC/AT, and allows developers to take full advantage of the capabilities of the 80286 microprocessor. Debugging features provided include hardware breakpoints and realtime trace of program execution. AT PROBE, $2,495; protected-mode software option, $975.
Atron, 20665 Fourth Street, Saratoga, CA 95070; 408/741-5900
CIRCLE 337 ON READER SERVICE CARD

With the **AT-Quiet X-Tend RT202-PC**, test and development engineers and technicians can monitor and debug circuit cards on the PC/AT without injecting noise or voltage drops. This four-layer extender card with power supply decoupling capacitors from **Rancho Technology** can be used for field service, prototype testing and calibration, quality testing, and engineering development. All signals are labeled with both the pin number and the signal mnemonic. Also available is the **RT201-PC**, designed for use with the PC and PC/XT. RT202-PC, $155; RT201-PC, $135.
Rancho Technology, 10238 Monte Vista, Rancho Cucamonga, CA 91701; 714/987-3966
CIRCLE 332 ON READER SERVICE CARD

SOFTWARE

The release of a powerful new database, **PractiBase**, has been announced by **PractiCorp International Inc.** Features include a full programming language, ability to convert and read dBASE II files and programs, access of up to three files at one time, and handling of as many as 60 fields per record with an unlimited number of records. PractiBase can handle 2,000 characters per record and 254 characters per field. Other features include the ability to generate customized reports, handle customized input and calculations, and provide data entry check. $99.95.
PractiCorp International Inc., The Silk Mill, 44 Oak Street, Newton Upper Falls, MA 02164; 617/965-9870
CIRCLE 344 ON READER SERVICE CARD

From GENISIS **Software** comes GENISIS **1.0**, an applications environment for the PC, PC/XT, and PC/AT with 256KB minimum memory, a hard disk at C:, DOS 3.0, and BASICA 3.0 or higher. GENISIS provides a utility for organizing all software in easy-to-use menus that may be nested to 10 levels with 12 items per menu. Menus may directly access .COM, .BAT, and .EXE files, other menus, and interpreted BASIC programs; subdirectories are supported. A login/logoff time accounting system, which tracks time by user and project with password protection, and a system manager for maintenance of the user, project, and time-used files and control of the menus are included. $29.95.
GENISIS Software, 416 Murdock Road, Baltimore, MD 21212; 301/377-0082
CIRCLE 341 ON READER SERVICE CARD

Version 2.0 of **db_Vista**, the database management system for software development in C under DOS or UNIX, has been announced by **Raima Corporation**. db_VISTA 2.0 includes source code, a royalty-free runtime license, three months of extended applications support, and product updates. This version features multiuser capability; transaction processing, which allows related changes to be written to disk; an interactive database access utility; the ability to import and export dBASE II/III and ASCII files; and an improved manual. Multiuser version with source code, $990; without, $495. Single-user version with source code, $495; without, $195. Demo version with manual, $50.
Raima Corp., 11717 Rainier Avenue S., Seattle, WA 98178; 800/843-3313 (dial 700-992 at the tone); 206/772-1515
CIRCLE 348 ON READER SERVICE CARD

A virtual memory system for programs designed to the Lotus/Intel/Microsoft expanded memory specification has been announced by SYSCOMP. Called **Micro VMS**, this system uses the computer's fixed disk or RAM disk to simulate the presence of one or more expanded memory boards in the system. Program operation under Micro VMS is slower than if an expanded memory board were installed. Among the programs supported by the system are Lotus's Symphony 1.1 and 1-2-3 2.0. $75.
SYSCOMP, 8825 Aero Drive, Suite 210, San Diego, CA 92123; 619/277-0400
CIRCLE 349 ON READER SERVICE CARD

AZTEC

Manx Aztec C86 is the best C for MS-DOS and you can prove it yourself!

"A compiler that has many strengths … quite valuable for serious work"
Computer Language review, February 1985

Manx Aztec C86 - The C For MS-DOS

Manx Aztec C86 is clearly the best C software development system for MS-DOS. Aztec C86 is the only C compiler for MS-DOS that provides the level of performance, features, documentation, and support required for serious, professional software development. You can prove it yourself. All you have to do is order Aztec C86 from Manx, evaluate it, and, if you like it, keep it. If you don't like it, send it back within 30 days and we'll cancel your order.

If you keep your Manx Aztec C86, as 99% do, you'll be in with the best company.

Manx Aztec C86 Features:

Optimized C compiler: Unsurpassed for code quality and speed. Optionally generates 80186 and 80286 code. Full K & R.

Symbolic Debugger: Execution trace, break points, display data in floating point, integer, character, or hex format. Evaluate expressions. Detect illegal memory stores, modify memory/registers, disassemble code.

Manx AS86 Macro Assembler: Supports macroes, 8086, 80186, and 80286 instructions in Intel format. Fast execution.

LN86 Overlay Linker: Links small, large, and mixed memory model routines, supports overlays, and options for producing ROM based code.

Librarian: Build and modify personal or system run time libraries.

8087/80287 Sensing Library: One library simulates floating point, another assumes the presence of an 8086 or 80287 math chip, the third senses the existence of a math chip, and if it finds one it uses it.

Profiler: Provides a run time analysis of your code to pinpoint code segments to optimize.

UNIX Library: Compatible with UNIX C. Fast I/O. Terminal I/O can be buffered or unbuffered.

DOS Library: Time and date functions, program forking (exec), program chaining, directory commands, I/O port support, sysint support, BIOS functions, and BDOS functions.

Screen & Graphics Library: Screen and cursor functions. Fast routines for drawing lines, circles, elipses, points, and setting colors.

CP/M-86 Library (-c): Produce programs for CP/M-86.

Large Memory Model: Manx Aztec C86 supports programs and data of any size. Global data has a max size of 64k.

Intel Object Option: Interface to software that requires Intel object format, such as PLINK86.

Z (vi) Source Editor (-c): Fast, powerful editor, Macro capabilities, undo, ctags, buffers for commands and data, and all the bells and whistles that make vi fanatics fanatical.

ROM Support Package (-c): Startup routine, linker options for separate placement of code and data, special utilities like the Intel HEX Utility, documentation, and library source.

Library Source Code (-c): UNIX, screen, graphics, and math function libraries.

Mixed Memory Models (-c): Mix large code and small data, small code and large data, or mix within type.

UniTools (-c): The UNIX utilities make, diff, and grep.

One year of updates (-c): As new versions are released, updates are automatically sent.

Technical Support: Manx has a full time staff to provide support via telephone & bulletin board.

Items marked -c are special features of the Aztec C86-c system.

Manx Aztec C86 is available in four configurations: Manx Aztec C86-c, Manx Aztec C86-d, Manx Aztec C86-p, and Manx Aztec C86-a. The -p and -a systems are not intended for commercial work and do not incorporate the same compilers as the -c and -d systems. All systems are upgradable.

Aztec C86-c Commercial System	**$499**
Aztec C86-d Developer's System	**$299**
Aztec C86-p Personal System	**$199**
Aztec C86-a Apprentice System	**$ 49**

Manx Cross Development Systems

Manx Aztec C compilers are available as native or as cross development systems for PC-DOS, MS-DOS, Macintosh, CP/M-86, CP/M-80, TRSDOS, Apple II, and Commodore 64/128.

Cross development involves two computer systems: the development system (HOST) and the execution system (TARGET). This method is useful when the TARGET machine is slower or more limited than the HOST.

HOSTS: VAX UNIX ($3000), PDP-11 UNIX ($2000), MS-DOS ($750), CP/M ($750), Macintosh ($750), CP/M-68k ($750), XENIX ($750).

TARGETS: MS-DOS, CP/M-86, Macintosh, CP/M-68k, CP/M-80, TRS-80 3 & 4, Apple II, Commodore C64, 8086/80x85 ROM, 68xxx ROM, 8080/8085/Z80 ROM, 65xx ROM.

Additional TARGETS are $300 to $500 (non VAX) or $1000 (VAX). Call for information, on cross development to the 68000, 65816, Amiga, C128, CP/M-68K, VRTX, and others.

How To Become a Manx Aztec C User

Call 1-800-221-0440 or 1-800-832-9273 (800-TEC WARE). In NJ or outside the USA call 201-530-7997. Orders can also be telexed to 4995812.

Payment can be by check, COD, American Express, VISA, Master Card, or Net 30 to qualified customers.

Orders can also be mailed to Manx Software Systems, Box 55, Shrewsbury, NJ 07701.

For More Information: call 1-800-221-0440, or 201-530-7997, or write to Manx Software Systems.

Manx maintains a large professional staff to service and support Manx users. You will get fast delivery and great service dealing directly with Manx.

Support Software for Manx Aztec C86

C-tree $395: B-tree database system. Easy to use. Available for Aztec C for MS-DOS, Macintosh, CP/M-86, CP/M-80, and others. Includes source.

PHACT $250: Powerful database system. Available for Manx Aztec C compilers for MS-DOS, CP/M-86, CP/M-80, and Macintosh.

PANEL $295: Create screens via simple, powerful editing commands. Select colors, edit fields. Directly input data to a multi-keyed file utility included with the system.

SunScreen $99: Create and modify formatted screens easily. Validate fields, select colors, create screens for both the color and monochrome cards. With library source SunScreen is $199.

WindScreen $149: Combines SunScreen with a powerful window utility.

Windows for C $195: Versatile window utility that supports IBM PC compatible and some non-compatible environments.

AMBER Windows $99: Powerful, low priced window package.

HALO $250: The ultimate C graphics package. It supports viewports, shapes, and multiple graphics cards. A less expensive version is available for just the PC mono and color cards.

FirsTime $295: Syntax checking while you edit greatly shortens compile time.

Pre-C $395: Powerful Lint-like utility locates structural and usage errors. Easily checks multiple files for bad parameter declarations and other interface errors. Lint users will find the user interface a dream come true.

PC-LINT $98: Lint-like utility that supports large memory models, has clear error messages, and executes quickly, has lots of options and features that you wouldn't expect at this low price.

Greenleaf Functions $185: Source for over 200 C and assembler functions. They are great, they work, they are used extensively, and are economically priced. Clear documentation and easy to use interface round out an impressive package.

C Utility Library $185: C and assembler source for screens, windows, color graphics, asynch communications, and more. The color graphics and speed of this package are impressive.

Plink-86 $395: MS-DOS linkage editor for producing and maintaining overlayed programs. It works with Aztec C86 in Intel object format mode.

30 Day Guaranty:

Any Manx Aztec development system can be returned within 30 days for a refund if it fails to meet your needs. Restrictions are that the original purchase must be directly from Manx, shipped within the USA, and the package must be in new condition. Returned items must be received by Manx within 30 days. A restocking fee may be required.

Discounts:

There are special discounts available to professors, students, and consultants. A discount is also available on a "trade in" basis for users of competing C systems.

Manx Aztec C Distribution:

In the USA, Manx Software Systems is the exclusive distributor of Aztec C. Telephone or mail order sales other than through Manx are unauthorized.

MANX

To order or for information call:

800-221-0440

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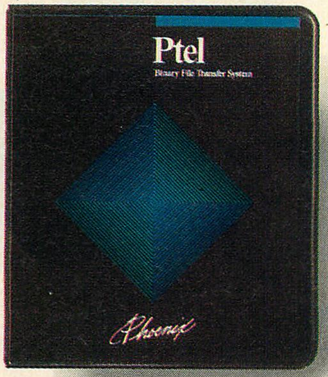


Enhanced Ptel communications

By Merrill Street Software/BCC, Inc.

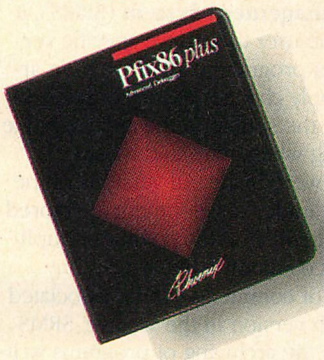
SCI Corporation announced that it has constructed a software package that permits PC software to operate on IBM mainframe computers without modification. **VirtualPC**, written in IBM 370 assembly language, emulates both the microcomputer and the associated hardware of the PC, as well as the PC BIOS. VirtualPC consists of a software 8088 emulator, a control program and resident debugger for controlling the simulation, a set of routines that intercept requests for I/O services and perform the services using the host operating system, and display software that simulates the functions of an IBM monochrome display adapter by mapping the output of PC programs onto host-connected IBM 3270 workstations. The package supports programs that write directly to display memory. Price pending negotiations with vendors.
SCI Corporation, 2039 Carrhill Road, Vienna, VA 22180; 703/938-0731
CIRCLE 347 ON READER SERVICE CARD

SuperBatch, from **Merrill Street Software Division of BCC, Inc.**, integrates applications programs and MS-DOS batch filing capabilities to provide turnkey application system capabilities for microcomputers. SuperBatch is an extended batch file processor that moves among virtually any applications programs, but never interferes with their operation. It can store and execute an infinite number of keyboard commands and can run at any speed. Images can be held on the screen. $79.95.
Merrill Street Software Division of BCC, Inc., 251 Merrill Street, Birmingham, MI 48011; 313/645-5280
CIRCLE 345 ON READER SERVICE CARD

A new on-line software update capability and support, plus a line-oriented script language and forward and backward scrolling have been added to **Phoenix Computer Products Corporation's Ptel** communications package. Ptel is the first universal binary transfer program for the PC, PC/XT, PC/AT, and compatibles running DOS 2.0 or later. All popular protocols are supported, including ASCII, XMODEM, Modem7, Telink, and Kermit. $195.

Also from Phoenix comes a high-performance linkage editor designed especially for programmers working with large, complex programs. Called **Plink 86 plus**, the new linker features overlay caching, object file merging, overlay reloading upon function return, and automatic allocating of library modules to overlay structures. $395.

An advanced version of Phoenix's **Pfix 86 plus** symbolic debugger that offers programmers in MS-DOS environments configurable menus, configurable keys, and tracebacks to save trace histories is available. Pfix 86 plus can debug terminate-and-stay resident programs and operating system I/O drivers. $395.
Phoenix Computer Products Corporation, 320 Norwood Park S., Norwood, MA 02062; 617/762-5030
CIRCLE 346 ON READER SERVICE CARD



Pfix 86 plus advanced debugger

Concurrent Sciences, Inc. has introduced a new MS-DOS version of its software debugger SOFT-SCOPE. This new version supports all five of the new DOS languages introduced by Intel Corporation: C, Pascal, FORTRAN, PLM, and ASM. SOFT-SCOPE debugs code generated by the Intel high-level languages and provides a true source code interface to the software developer. It reports breakpoints and stepping with the actual source line, including comments, corresponding to the next line to be executed. SOFT-SCOPE can display automatically all variable types, including Pascal records, PLM and C structures, multidimensional arrays, and real types. Structure and array references may be partially qualified, resulting in a formatted display showing the name of each field and its current contents. Also provided is a terminal interface that allows all debugger interaction to be redirected to a second console, giving the program being debugged exclusive use of the main console. $500.
Concurrent Sciences, Inc., P.O. Box 9666, 106 E. Third Street, Moscow, ID 83843; 208/882-0445
CIRCLE 350 ON READER SERVICE CARD

Relational Database Systems, Inc. (RDS) has announced an agreement with IBM Corporation in which IBM will market three RDS products that run under the Interactive Executive for the System/370 (IX/370) operating system on IBM mainframes. IX/370 is the IBM implementation of UNIX System V. IBM will market **Interactive Executive Informix**, a relational database; **IX Informix Embedded Query Facility for C**, an interface between the Informix database and the C language; and **IX Informix Embedded Query Facility for COBOL**, an interface between the database and COBOL. These products use a query language similar to the SQL in IBM's SQL/DS and DB2. IX Informix, $48,000; C Query Facility, $36,000; COBOL Query Facility, $36,000.
Relational Database Systems, Inc., 4100 Bohannon Drive, Menlo Park, CA 94025; 415/322-4100
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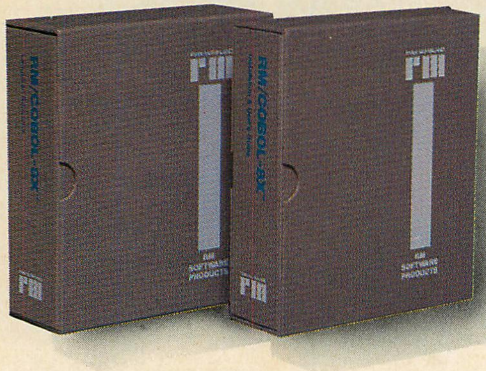
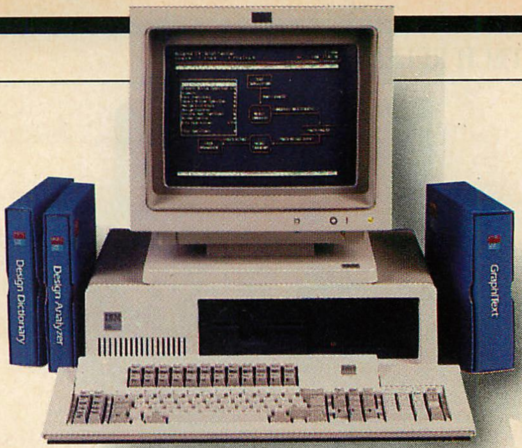
IBM Corporation; Contact the local IBM dealer, 800/426-2468
CIRCLE 343 ON READER SERVICE CARD





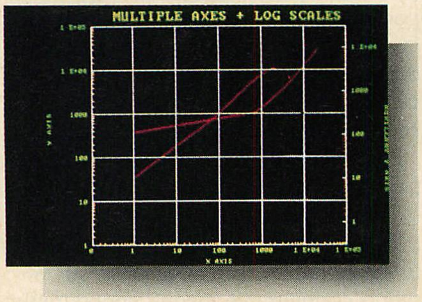
RM/COBOL-8X

DesignAid by Nastec

Ryan-McFarland Corporation has announced an advanced COBOL compiler for microcomputers that offers the combined advantages of portable application code and high-speed execution, and includes IBM mainframe COBOL extensions and key features in the ANSI X3.23 198x COBOL standards proposal. **RM/COBOL-8X** eliminates the 64KB program size restrictions to enable smaller systems to handle mainframe applications. RM/COBOL 2.0 developers can use a special compatibility switch that lets the compiler ignore new language features, such as ANSI 85 extensions. Full development system, $1,250; runtime only, $300.
Ryan-McFarland Corporation, 609 Deep Valley Drive, Rolling Hills Estates, CA 90274; 213/541-4828
CIRCLE 340 ON READER SERVICE CARD

PC Utilities has released a **machine code utility** that sorts 1,000 alphanumeric strings in one second on the PC/AT; it effectively adds a sort command to BASIC. File I/O is left to the user, permitting optimum performance by the applications software. It is limited by the maximum memory available or the upper limit of the operating system. PC Utilities can modify the source code with interface to other languages. Contact the company for prices.
PC Utilities, 20 Laxey Road, Horfield, Bristol BS7 OJA, England; 0272/520423-731796
CIRCLE 355 ON READER SERVICE CARD

TEKMAR is a graphics library for use with the PC and Tecmar Graphics Master, it includes functions that can be called from programs. Produced by **Advanced Systems Consultants**, this library is written in assembly language and FORTRAN for speed, portability, and flexibility. TEKMAR requires Microsoft FORTRAN 3.3 or Lahey Computer Systems' F77L. (A version for IBM's Professional FORTRAN is under development.) In addition to the high-level graphics library, applications such as a contour-finding program are included. $195.
Advance Systems Consultants, 18653 Ventura Blvd., Suite 351, Tarzana, CA 91356; 818/407-1059
CIRCLE 354 ON READER SERVICE CARD



TEKMAR screen

A set of related utilities designed to help software developers keep track of changes to the source code of computer programs has been released by **Quilt Computing.** Called **Software Revision Management System** (SRMS), it allows the user to retrieve specific versions of a program from a common archive, apply changes to the source, and reinstate the source in the archive while recording when, why, and where changes were made. All versions of the program under development are stored in a single SRMS library, without duplication of common code or text. Any number of comments can be associated with each version in the archive. SRMS supports the archiving of programs written in BASIC, FORTRAN, Pascal (including Turbo Pascal), C, and assembly language. $99.95.
Quilt Computing, 7048 Stratford Road, Woodbury, MN 55125; 612/739-4650
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New development tools and capabilities have been announced for **Nastec Corporation**'s DesignAid. **SafeSpan** provides a bridge between DesignAid and PSL/PSA (problem statement language/problem statement analyzer). With PSL/PSA and DesignAid as a front end, system developers can work with structured analysis and design notation without needing to be fluent in the syntax of PSL statements used as input to the host-based PSA. $1,700.

JaDesign supports IBM's Joint Applications Design (JAD) methodology through PC implementation of the JAD forms, procedures, and methods. During the JAD session, the PC captures all user-view prototypes, screens, reports, and associated documentation. $5,000 by site license.

Version 3.2 of **DesignAid** adds automated balancing for Yourdon data flow diagrams and an enhanced Design Dictionary to catalog the hierarchical data and process structures captured during the balancing process. $6,900.
Nastec Corporation, 24681 Northwestern Highway, Southfield, MI 48075; 313/353-3300
CIRCLE 352 ON READER SERVICE CARD

A software facility that gives third-party computers a connection into IBM's next-generation networking scheme has been introduced by **The Orion Group, Inc.** The **sna62 Peer Communications Facility** implements IBM SNA "peer-to-peer" communications protocols (LU 6.2 and PU 2.1). These protocols enable microcomputers, minicomputers, and mainframes, as well as terminals, file servers, and other devices, to exchange data directly. The facility is written in C under UNIX V.
The Orion Group, Inc., 1912 Bonita Way, Berkeley, CA 94704; 415/548-0947
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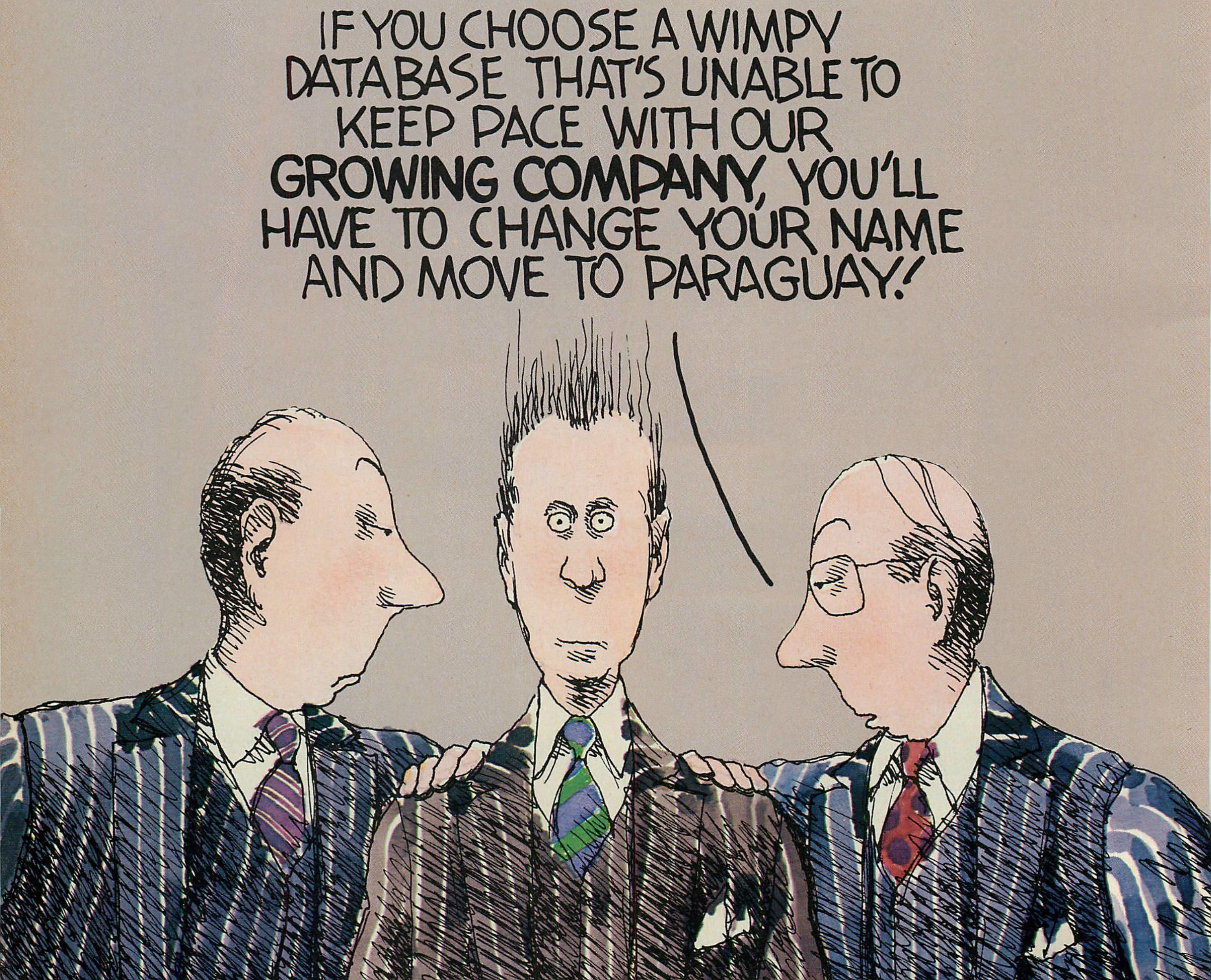

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Procedural Language	Yes	Yes	Yes
Variable Length Fields	Yes	No	No
Multiple Values in Fields	Yes	No	No
Report Writing Features:			
A) Access to Date/Time	Yes	Yes	No
B) Row or Column Formats	Yes	Yes	No
C) Accessible Tables	6000	40	10
Password Security	Yes	Yes	No
Definable Data Entry Rules	Yes	Yes	No
Mainframe Communications (1)	Yes	No	No
Application Generator	Yes	Yes	Yes
Procedural Language Compiler	Yes	No	Yes (2)
Run-Time Module	Yes	Yes	Yes
Network Version	Yes	Yes	Yes

1) From original manufacturer. 2) Extra cost option not available on network version. dBase III Plus is a trademark of Ashton-Tate. R:Base 5000 is a trademark of MicroRIM, Inc. IBM is a registered trademark of International Business Machines Corporation. NetWare is a trademark of Novell, Inc. EtherSeries is a trademark of 3COM Corporation.

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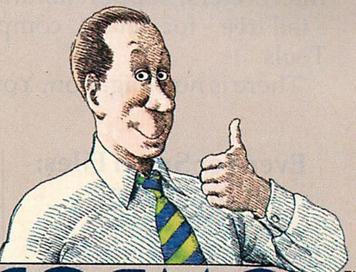

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TECH NOTEBOOK 56

TED MIRECKI

Tracing Expanded Memory

A user can keep tabs on the allocation of expanded memory within a system.

Users may find it helpful to keep track of the amount of memory provided by an expanded memory specification (EMS) board that actually is being used. Program XMEM.ASM, shown below, displays the total expanded memory in the system, the amount allocated for particular applications, and the amount remaining. (See "Expandable Memory," p. 66.)

The program determines if EMS is installed, then uses EMM function 3 to report the size of expanded memory present. Function 14 is invoked to fill an array with the ID of each application as well as the number of pages allocated to it. After the array is filled, function 12 is used to return the number of processes currently using expanded memory .

LISTING: XMEM.ASM

```
PTOTAL  EQU     42H      ;DEFINE EMM FUNCTION CODES
PCOUNT  EQU     4BH
PBYPROC EQU     4DH
DISPLAY MACRO            ;DISPLAY STRING AT DS:DI
        MOV     DX,DI
        MOV     AH,9
        INT     21H
        ENDM
EMMCALL MACRO   FUNCT
        LOCAL   NOERR
        MOV     AH,FUNCT
        INT     67H      ;PERFORM EMM FUNCTION
        OR      AH,AH    ;TEST FOR ERRORS
        JZ      NOERR
        LEA     DI,ERR$ ;IF ERROR, EXIT W/MESSAGE
        JMP     EXIT
NOERR:                   ;CONTINUE HERE IF NO ERROR
        ENDM
CODE    SEGMENT
        ASSUME CS:CODE, DS:CODE, ES:CODE
        ORG     100H
XMEM    PROC
        JMP     PASTDATA
ERR$    DB      'Expanded Memory Error',13,10,'$'
TOTALK$ DB      '     0 K Total Expanded Memory',13,10,'$'
EACHK$  DB      '       K used by process'
PRNUM$  DB      0,0,0,0,0,0,13,10,'$'
FREE$   DB      '       K free',13,10,'$'
EMMNAME DB      'EMMXXXX0'      ;NAME OF EMM DEVICE DRIVER
FREEPAGES       DW      0       ;UNALLOCATED PAGE COUNT
PAGES   DW      256 DUP (0,0)   ;ARRAY OF PAGE COUNTS
PASTDATA:       PUSH    ES
        MOV     AX,3567H        ;GET INT 67 VECTOR
        INT     21H
        MOV     DI,10   ;POINT TO DEVICE NAME
        LEA     SI,EMMNAME      ;POINT TO EMM NAME
        MOV     CX,8
        CLD
        REPE CMPSB      ;IS EMM INSTALLED?
        LEA     DI,TOTALK$      ;MSG IN CASE IT ISN'T
        JNE     EXIT    ;EXIT IF NO EMM
        POP     ES
        EMMCALL PTOTAL  ;DETERMINE TOTAL PAGE COUNT
        MOV     AX,DX   ;PAGE COUNT RETURNED IN DX
        MOV     FREEPAGES,AX    ;SAVE IT
        LEA     DI,TOTALK$
        CALL    P2K     ;CONVERT PAGES TO K
        DISPLAY
        LEA     DI,PAGES        ;POINT TO ARRAY OF PAGE COUNTS
        EMMCALL PBYPROC ;GET PAGES PER PROCESS ÉjÉ
```

```
EMMCALL PCOUNT  ;GET EMM PROCESS COUNT
MOV     CX,BX   ;PROCESS COUNT TO CX
JCXZ    X2      ;SKIP IF NO EMM PROCESSES
        MOV     SI,DI   ;POINT SI TO PAGE ARRAY
X1:     LODSW           ;GET PROCESS ID
        CBW             ;CONVERT LOW BYTE ONLY
        LEA     DI,PRNUM$
        CALL    I2ASC   ;CONVERT # TO ASCII
        LODSW           ;GET PAGES FOR THIS PROCESS
        SUB     FREEPAGES,AX    ;UPDATE FREE PAGE COUNT
        LEA     DI,EACHK$
        CALL    P2K     ;CONVERT PAGES TO ASCII K
        DISPLAY         ;DISPLAY PROCESS COUNT
        LOOP    X1      ;CONTINUE FOR ALL PROCESSES
X2:     MOV     AX,FREEPAGES
        LEA     DI,FREE$
        CALL    P2K
EXIT:   DISPLAY         ;DISPLAY LAST MESSAGE
        INT     20H     ;THAT'S ALL, FOLKS
XMEM    ENDP
P2K     PROC
        SHL     AX,1    ;KBYTES = PAGES * 16
        SHL     AX,1
        SHL     AX,1
        SHL     AX,1
I2ASC:  PUSH    DI      ;ENTER HERE IF # IS NOT PAGES
        PUSH    CX
        CLD
        PUSH    AX
        MOV     AL,' '  ;BLANK OUT STRING
        MOV     CX,6
        REP STOSB
        DEC     DI      ;POINT AT STRING END
        MOV     BX,10   ;BASE TEN DIVISOR
        POP     AX      ;GET BINARY NUMBER INTO AX
        STD             ;MOVE BACKWARDS THRU STRING
DIVLOOP:        CWD             ;CONVERT TO DBL WORD IN DX,AX
        DIV     BX      ;QUOTIENT IN AX, REMNDR IN DX
        XCHG    AX,DX   ;EXCHANGE QUOT & REM
        OR      AX,30H  ;CONVERT TO ASCII DIGIT
        STOSB           ;STORE ASCII CHAR IN STRING
        MOV     AX,DX   ;RESTORE QUOTIENT TO AX
        OR      AX,AX   ;TEST IF MORE DEC DIGITS
        JNZ     DIVLOOP
        POP     CX      ;RESTORE & EXIT
        POP     DI
        CLD
        RET
P2K     ENDP
CODE    ENDS
        END     XMEM
```

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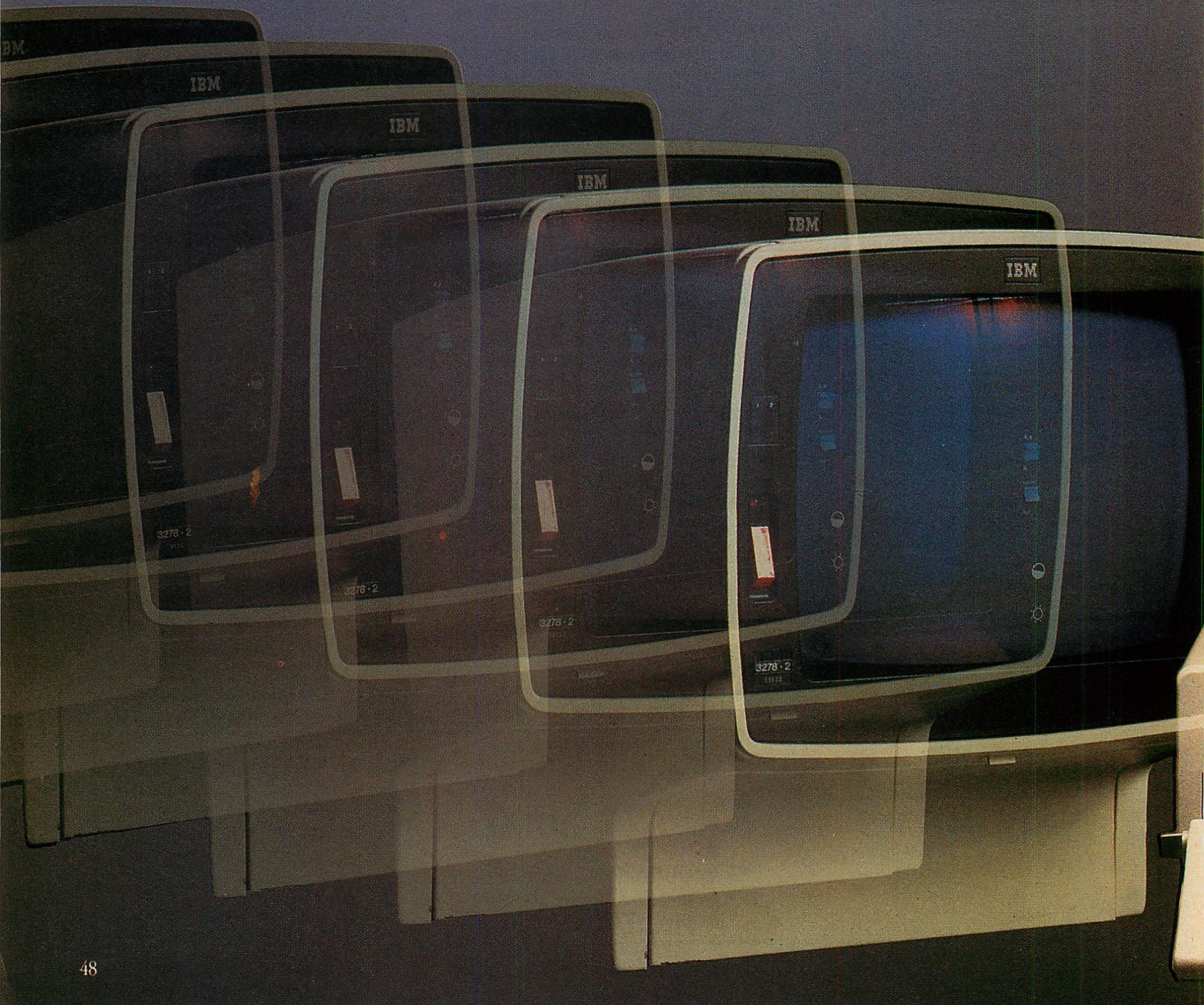
Emulating the 3278

Users need PCs that function both as stand-alone units and as workstations for mainframe communication. The choices currently available that provide 3278/79 terminal emulation are many.

ROGER ADDELSON



The trend in terminals is changing from the dedicated slave to the multipurpose workstation. As such, the PC provides local computing power and access to the mainframe for programs, databases, and electronic mail. The mainframe can act as a central data repository, enabling non-networked PCs to share information through file transfer.

The PC may be implemented as a workstation in several ways. Where the need exists and the topology is feasible, the local area network (LAN) connected via a gateway to the mainframe is a popular choice. Under a LAN, each workstation must function independently as both a mainframe terminal and a local PC. In cases where a LAN is not practical or necessary, 3278/79 terminal emulation may be the answer.

The 3278/79 terminal (information display system) is a workhorse for IBM mainframes. This high-speed intelligent terminal offers full-screen capability. Most corporate 3278/79 terminals are connected from host mainframes via coaxial cable to a 3274/76 cluster controller, which then communicates with the mainframe over a high-speed binary synchronous line. This communication often is accomplished under IBM's system network architecture (see "SNA Strategies," Art Krumrey, July 1985, p. 40.) Emulation of the 3278/79 is essential to workstations operating in an IBM mainframe environment. A PC can emulate a 3278/79 through

- a LAN gateway, where a device on the LAN serves as a 3274/76 controller and each PC emulates a 327x terminal. (See figure 1.)
- dial-in 3276 emulation, where a single PC is used to emulate both a cluster controller and a 327x terminal. This option also uses telephone lines and modems. (See figure 2.)
- coaxially connected 327x terminal emulation, where a single PC is directly connected to a cluster controller and acts as a 327x device. (See figure 3.)

The dial-in option provides the 3278/79 emulation—and is the only option when cluster controllers are not available—but the maximum transfer speed is only 2400 baud even with recently released modems. This can be frustrating with program files of 50KB to 100KB or full 1,920-character screens.

The last method is the obvious choice when LAN gateways are not present but 3274/6 cluster controllers are.

PHOTOGRAPH • MARC DAVID COHEN

FIGURE 1: *Emulation via LAN Gateway*

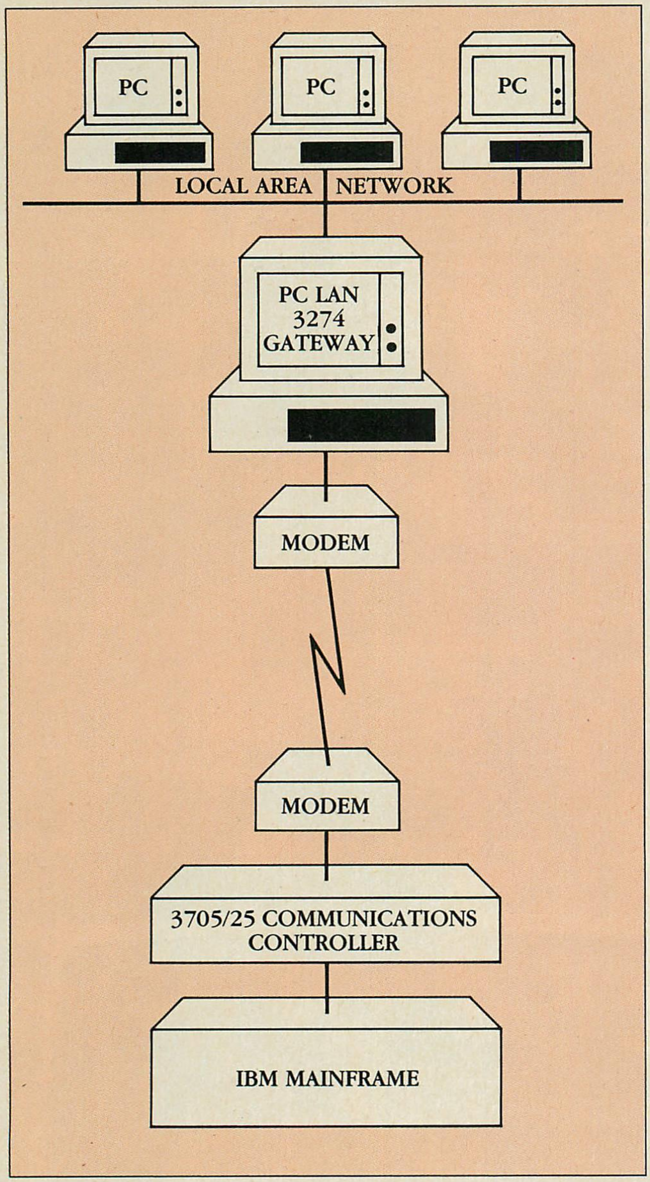
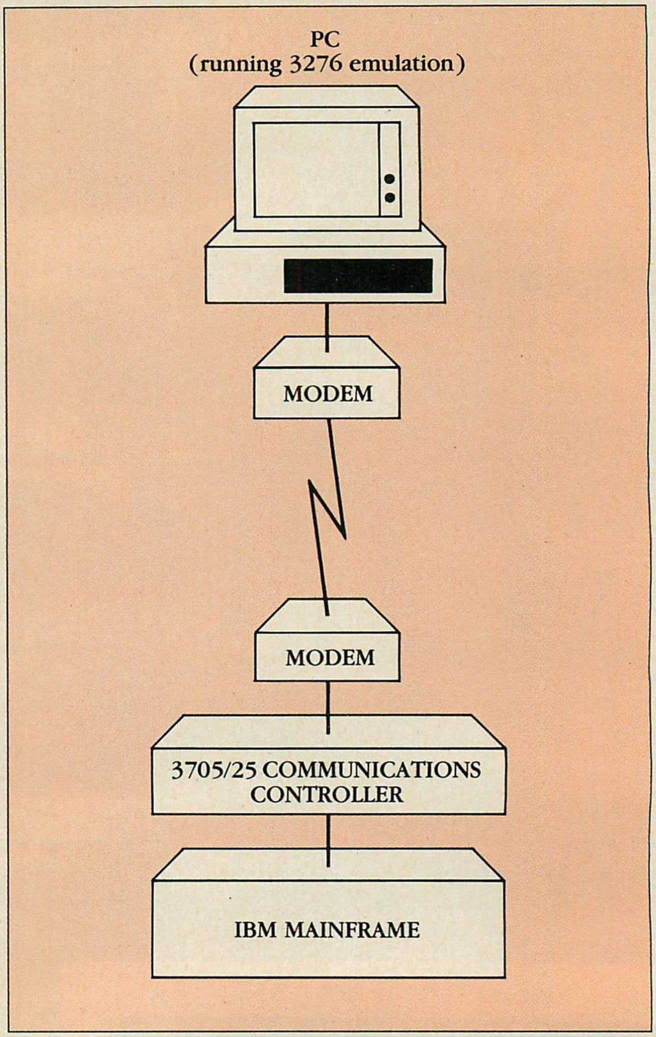


FIGURE 2: *Connection via 3276 Emulation*



In figure 1, a device on the LAN (not necessarily a PC) emulates a 3274/76 cluster controller and connects to the mainframe via a high-speed line. In figure 2, a PC emulates both 3278/79 terminal and 3276 cluster controller. This method is not economical if the cost of the line is high.

The coaxially connected emulators are attached to IBM 3274/6 cluster controllers and communicate with them at speeds of 2.63MB per second. The controllers communicate with the mainframe at speeds ranging from 9600 baud with a leased line to 56Kbaud on a T1 carrier to direct channel connect speeds of up to 3MB per second.

This article evaluates eight coaxially connected 3278/79 emulation hardware/software packages currently on the market. This review is confined to boards distributed by the original makers to avoid comparing a board with itself under another label.

SERVICES RENDERED

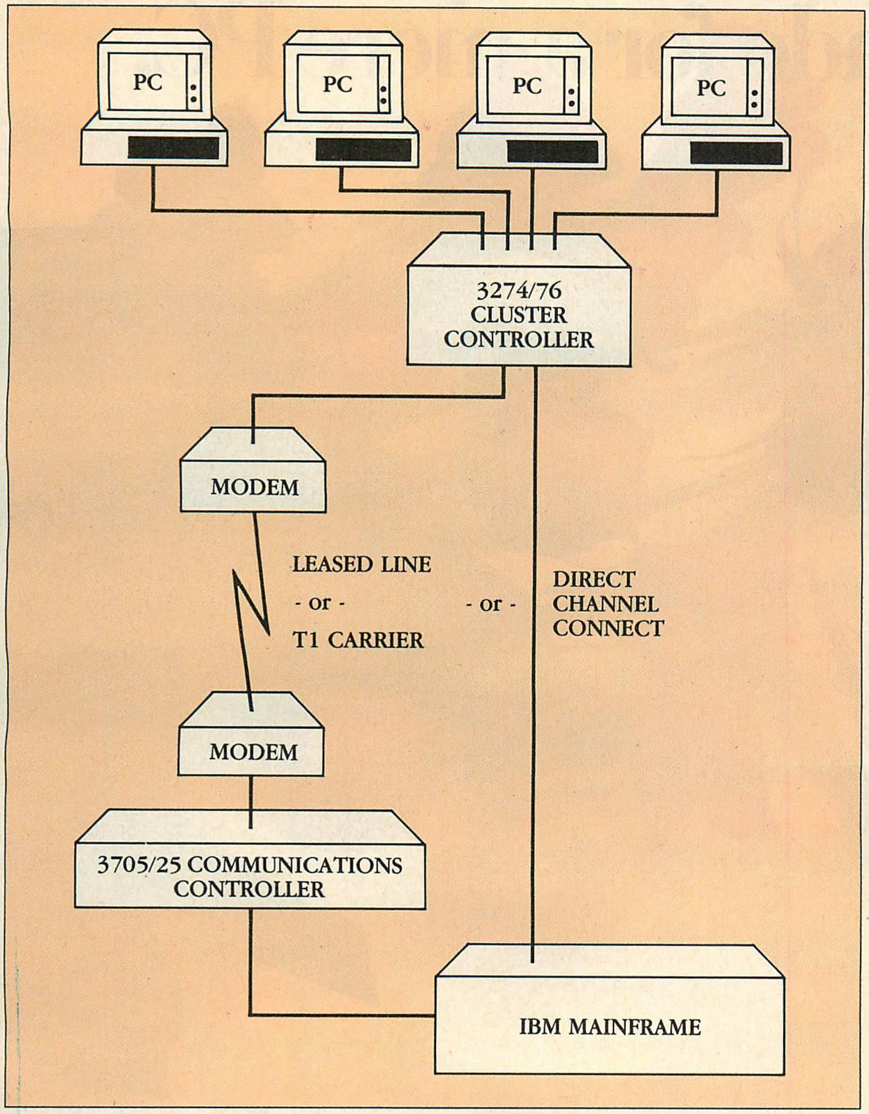
The basic service supplied by an emulator board with software is a functional duplication of the 3278/79 terminal on a PC with monochrome or color adapters and monitors. The several terminal models available differ in the number of characters displayed: 1,920 (24 lines by 80 characters); 2,560 (32 lines by 80 characters); 3,564 (27 lines by 132 characters); or 3,640 (43 lines by 80 characters); with regular or extended attribute bytes for the 3278 and base (4) or enhanced (16) color for the 3279. Models 3278-2 and 3279-2A are the most common display systems and the most widely emulated. Some boards emulate several 3278/79 models.

Some 3279 terminals also offer graphics adapter support, permitting terminal display of mainframe-generated color graphics. Some mainframe software packages (GDDM—Graphical Data Display Manager—and SAS GRAPH, for example) require this support; a few of the 3279 emulators make it available as an added feature.

Users, however, also need to transfer local PC data to the host mainframe and vice versa. This raises many questions: Are file transfers supported under CMS? Under TSO? Can binary files such as load modules be transferred, or only text files? Because the files are stored in ASCII on the PC and in EBCDIC on the mainframe, are the data automatically translated between the two character encoding schemes? Is integrity (error) checking performed during the transfer? Is there a mainframe software component to the file transfer? If so, how is it installed? These and other questions are answered in various ways by the 3278/79 emulator packages.

Consider the PC keyboard. Its layout is different from that of the

FIGURE 3: *Mainframe Connection through Cluster Controller*



This configuration is common practice in large 3278/79 terminal installations. It permits 3278/79 terminals to be mixed with emulator-equipped PCs.

3278/79; therefore, each 3278/79 key must be mapped onto a corresponding key on the PC. If every 3278/79 key is not duplicated on the PC emulator, then a degree of 3278/79 functionality is lost. Most of the emulators duplicate 90 percent of the standard keys and functions, with the exception of the Cursor Select and Screen Print keys. Cursor Select allows a terminal without a light pen to simulate an entry in a pen-selectable field, an important factor in many CICS applications. Screen Print allows a 3278/79 to dump screen images to a printer connected to the 3274/6 controller. Most emulators do not support this function, but provide screen dumps to a printer connected directly to the PC.

A workstation PC must operate simultaneously as a 3278/79 terminal and a stand-alone computer. Most emulators accomplish this through memory-resident software that allows the user to switch between 3278/79 sessions and DOS with a "hot key." DOS reentrancy problems limit the screen-image capture feature in resident emulator software; because of this, many packages also offer a nonresident mode, in which switching to a 3278/79 session requires reloading the emulation software each time. Note, however, that because most 3278/79 boards have on-board processors and memory, exiting a nonresident session does not mean a loss of connection or session with the host.

Ease of installation is an important consideration, particularly when specialized software must be installed on the mainframe. A user experienced only with applications programs on the PC needs clear, step-by-step documentation on the mainframe file-transfer component. This job should fall under the realm of the systems software group; but in many cases, the PC user is unsupported by the MIS department.

The installation of the board itself is also a concern. Because all PCs are not configured identically, a unique interrupt level for the emulation board is not always possible, and neither is a unique address for the board's memory. Although the board may be set to a default interrupt level and address at the factory, it must permit easy reconfiguration during installation—generally with the use of DIP switches and jumpers. The documentation must be clear, pointing out potential conflicts with system resources such as serial or parallel ports or BIOS routines. The product should include diagnostics to test the emulator in case of initial malfunctions. Table 1 lists the products' features.

EMULATION EVALUATION

These 3278/79 emulation packages were tested on an IBM 3081-D mainframe running OS/MVS, TSO, and ISPF. They were attached to a 3274 cluster controller communicating via a T1 carrier to a remote 3705 communications controller using IBM's SNA protocol.

IBM 3278/79 Emulation Adapter. IBM sells the full-length, single-slot board, control program, and mainframe components of the file-transfer software separately. The package emulates only the 3278-2 and the 3279-2A/S2A, which means it is limited to four colors and does not support mainframe graphics in 3279 emulation. The installation of the mainframe software is better left to a systems specialist in spite of the clarity of the documentation. However, even the neophyte could handle the step-by-step instructions for creating a working diskette and starting up the emulation software.

The IBM file-transfer program is excellent. It is supported under both VM/CMS and MVS/TSO and uses the same protocol and mainframe software as the IBM 3270-PC. This protocol has been adopted by several other manufacturers of 3278/79 boards and has become a de facto standard. The program supports the transfer of both text and binary files of varying record lengths on both the mainframe host and the PC, and includes extensive validity check ing. Files are transferred rapidly in 4,096-byte blocks. In addition, the program is able to perform ASCII/EBCDIC translations.

The memory-resident emulator software functions well, permitting the user to switch easily between a DOS

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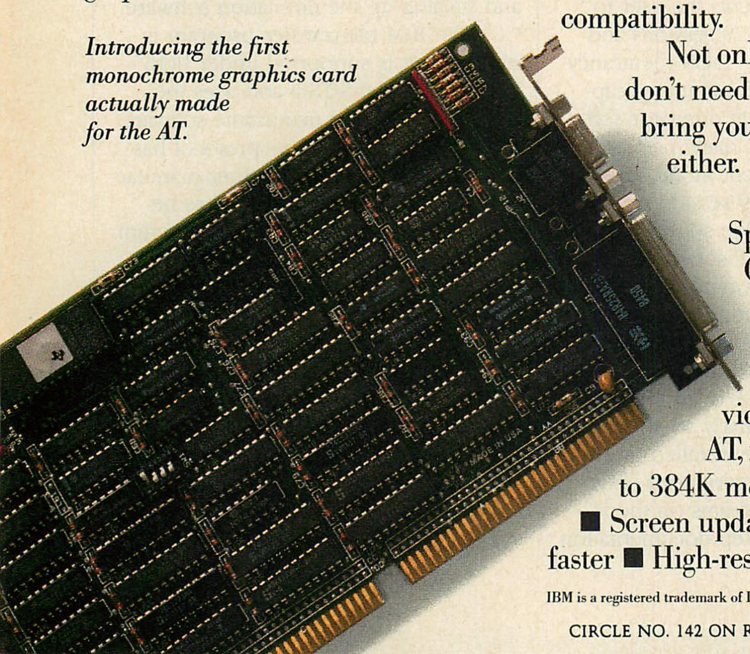

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TABLE 1: *3278/79 Emulators Features Comparison*

	IBM	PERSYST	LINKUP	FORTE	ATTACH.	IRMA	IDEA.	PCOX
3278/79 models emulated	2	2	2	2,3,4	2,3,4,5	2,3,4	2	2,3,4,5
Mainframe color graphics	No	No	No	Yes	No	No	No	No
3278 keyboard	Full[a]	Part.[a]	Full	Full	Full	Full	Full	Full
International keyboards	No	Yes	No	Yes	Yes	No	No	Yes
Keyboard reconfiguration	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Supports 3274 Entry Assist	Yes	No	No	No	No	Yes	No	Yes
Light-pen support	No	No	No	No	No	Yes	No	No
IBM compatible support	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Printer support								
On controller	Yes	No	No	No	Yes	Yes	Yes	Yes
Local	No	Yes	Yes	Yes[b]	Yes	Yes	Yes	Yes
Screen image to disk	No	Yes[b]	Yes[b]	Yes[b]	Yes	Yes	Yes	Yes
File transfer								
Slow—editor oriented	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Fast—mainframe program	Yes	No	No	Yes	Yes	Yes	No	Yes
Ease of installation								
Hardware	Good	Good	Fair	Good	Good	Good	Good	Good
Software	Good	Good	Fair	Good	Good	Good	Good	Good
FTP	Good[c]	Poor	Poor	Good[c]	Good[c]	Good[c]	Good	Good[c]
Changeable I/O address, memory address, interrupt	No	Yes	No	Yes	Yes	No	No	Yes
BASIC access to board	No	No	No	No	No	Yes	Yes	Yes
Diagnostic programs	No	Yes[d]	Yes[d]	Yes	Yes	No	Yes	Yes
Documentation								
Installation	Good	Good	Poor	Excel.	Good	Excel.	Excel.	Excel.
Operational	Good	Good	Poor	Excel.	Good	Excel.	Excel.	Excel.
Troubleshooting	Poor	Good	Poor	Excel.	Good	Poor	Excel.	Excel.
Overall performance	Good	Fair	Good	Good	Excel.	Excel.	Good	Excel.

[a] No Cursor Select key.
[b] Only in nonresident mode.
[c] Requires mainframe knowledge.
[d] Only on power-up.

IBM's emulator, while a good performer, is feature poor in comparison. Only FORTE PJ supports mainframe color graphics.

session and a 3278/79 session with Alt-Esc. Other key combinations let the user reboot DOS while retaining the emulation session or completely suspend the DOS session. The user also may start up the PC with only a 3278/79 session and initiate DOS later.

IBM's 3278/79 Emulation Control Program redefines the PC keyboard to include virtually all functions of the 3278/79 keyboard (U.S. English only, international versions are not supported). The only important key missing is Cursor Select, which prevents the use of this emulator in some CICS applications. The IBM emulator is one of the few that supports 3274 Entry Assists.

This package does have its shortcomings. For example, although the emulator permits output to a printer attached to the cluster controller, it has no provision for screen dumps from a 3278/79 session to a local printer attached to the PC. Another convenient feature offered by many emulators but absent in the IBM emulator is the ability to save screen images to the PC's disk.

Further, the interrupt vectors (50H through 57H) and I/O port (2D0H through 2DFH) used by the IBM board are permanently set. Any applications or other boards that use these addresses may not operate concurrently; applications that write directly to the video buffer also can cause conflicts. But a more serious problem is presented by the 3278/79 Emulation Control Program, which examines the ROM BIOS for the IBM copyright message. If the message is not found in ROM, the program returns to DOS with an error message—the product is incompatible with anything but an actual IBM PC.

The emulation package also falls short in another area: no diagnostic routines are provided and the troubleshooting documentation is at an elementary level. For example, if the answer to the question "Did the program load successfully?" is no, the user is advised to "Contact the point of purchase of your PC3278 Control Program."

Persyst/Emulex COAX/3270. Persyst, a division of Emulex, Inc., produces the COAX/3270, which includes a single-slot, full-sized board and emulation software. The COAX/3270 File Transfer Program, written by CDI Systems, Inc., is sold as a separate product. Like the IBM emulator, the COAX/3270 can duplicate but a few 3278/79 models, in this case, the 3278-2 or 3279-S2A/S2B. It provides base color support only and no mainframe graphics.

The file-transfer package comes on a diskette with an awkward copy-protection scheme. The first attempt to create a working disk, following the directions in the package, produced an unsuccessful copy—the program would not run. A second attempt was thwarted by the protection scheme, which allowed only one copy. A call to CDI Systems, Inc. (not Persyst) produced a code that permitted another copy. This time the batch files were examined and a minor error corrected; the working copy was made by executing each step manually.

The COAX/3270 file-transfer package works with both CMS and TSO. The CMS version supports only text files; the

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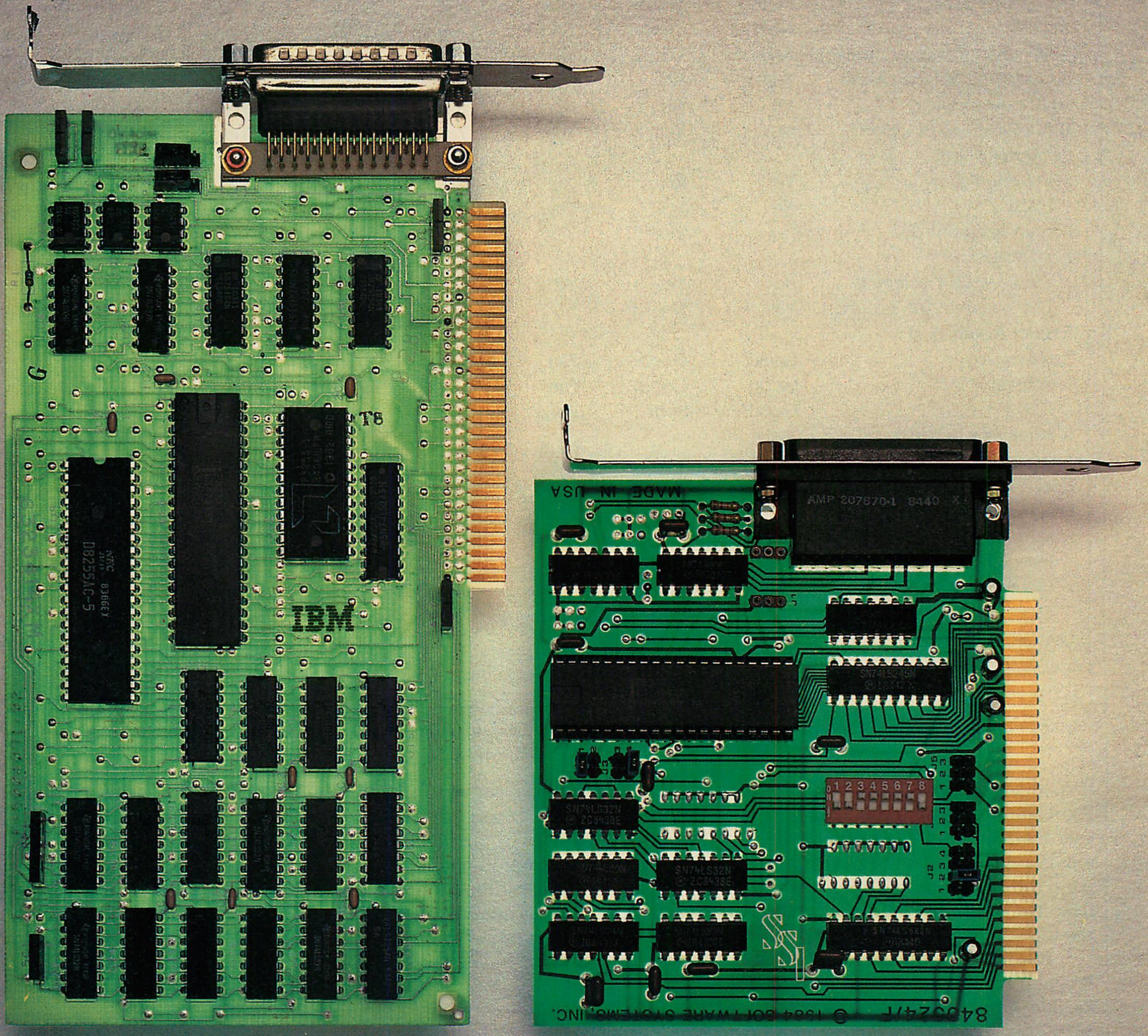

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TSO version supports text and binary files. Both use the mainframe editor (XEDIT for CMS, EDIT for TSO). Each of these editors allows files of varying record lengths to be transferred. However, because this package has no host-based file-transfer software, validity checking is *not* performed during the transfer. Under the CMS option, files are transferred by records rather than in large blocks, which makes transfer much slower. Like IBM, COAX/3270 handles the ASCII/EDCDIC conversion. The speed of file transfer under TSO depends upon an installation's TSO EDITOR work-file size. The larger the work file, the faster the transfer. The rates can approach those of IBM.

The installation for this package is well documented. All of the files on the distribution diskette are explained, and instructions are given for backing up the files and creating a working disk. The emulation software is written by Persyst, not CDI, and it is *not* copy protected; its installation went smoothly. In addition, the user may reconfigure the address of the board's 32KB memory (initially C0000H-C7FFFH) and the interrupt level (initially level 3) via DIP switches and jumper blocks.

The emulator performed as promised, although the screen behaved strangely while capital letters were being entered. (The cursor went to the bottom left screen position after each keystroke of an uppercase character.) It includes some important features, such as screen image capture to the local printer, or, if the emulator is not memory resident, to disk; extensive on-line help; and the ability to run in resident or nonresident mode. In resident mode, the user may switch to and from the DOS session using the Shift-Shift combination. Note, however, that this poses a potential conflict with SideKick, which also uses Shift-Shift.

The COAX/3270 software comes with a redefinition of the PC keyboard to the functions of the 3278/79 keyboard (U.S. English edition). The package also includes definitions for the British, French, German, Italian, and Spanish keyboards. Or, the user may create keyboard definitions using a utility program provided in the package. In spite of all this, several important 3278/79 keyboard features are missing from the COAX/3270 keyboard definition, including Apostrophe, Attn, Ident, NumLock, Sys Req, and, as in the case of IBM, Cursor Select.

The hardware provides a self-test diagnostic feature at power-up, but this is as far as the diagnostics go. No routines are included to test for a correct installation. A brief appendix in the manual gives limited but well thought-out hints for troubleshooting.

LINKUP System COAX. Information Technologies, Inc. produces this system, which includes a single-slot, full-sized board, emulation software, and file transfer software as an option (at extra cost). Although the documentation states that LINKUP emulates a 3278-2 display station only, 3279-S2A emulation can be achieved using the color redefinition utility provided in the package. However, ITI's emulator does not provide support for 3279 graphics.

As with the Persyst COAX/3270, LINKUP's optional file-transfer software was written by CDI Systems. The programs exhibit similar features and appear to function identically: the LINKUP program has a similar copy protection scheme and it supports both CMS (text only) and TSO (text and binary) via the mainframe editors. Its limitations also are similar: it has no validity checking, and it operates slowly in CMS and only moderately faster in TSO.

Through memory-resident software, most emulators allow the user to switch between 3278/79 sessions and DOS with a "hot-key" combination, typically Shift-Shift.

The hardware installation instructions consist of two sentences: "Instructions for installing option boards, such as LINKUP Coax, in IBM Personal Computers are provided in the options section of the IBM Personal Computer Hardware Reference Library *Guide to Operations.* For installation of the LINKUP Coax in IBM-compatible personal computers, refer to the computer manufacturer's user documentation for specific instructions on installing option boards." No information about board addresses, interrupt levels, or possible conflicts with other peripherals or programs is provided; nor are instructions for backing up the diskette or making a working copy included. A neophyte may feel forced to use the distribution diskette, a dangerous situation.

Nevertheless, the LINKUP emulator is a versatile package. The appearance of the 3270 status line is much like that of the IRMA board (see below), with excellent graphic representation of the status line symbols. The emulator operates in memory-resident and nonresident modes. In resident mode, some of the extended features, such as screen image capture to disk, do not function. The package provides hot keys for the conversion between modes, to switch between DOS and 3278 sessions, to convert from color to monochrome display, and to capture screen images to local printers in either mode.

The LINKUP software offers a rather complete U.S. English keyboard. Although it does not support international versions, it does include a utility that allows the user to redefine the 3270 keyboard in any manner. In addition to the standard keys offered, LINKUP includes such useful extras as Attn, Sys Req, Ident, Test, and (for CICS users) Cursor Select. It even has equivalents of the 3278 cursor fast movement keys.

The manual for this package is extremely poor. It has no information on error messages, diagnostics, or troubleshooting, but it does list a telephone number for technical support. The hardware does offer two innovative, firmware-based diagnostic tests: a power-on test (which was not seen in action because the evaluation board functioned properly) and a coax test that is invoked from the keyboard with the results displayed in the status line.

FORTE PJ (3278/79). This product from Forte Data Systems includes a single-slot, full-sized board and software that allows the PC to emulate 3278 models 2, 3, and 4 and 3279 models S2A, S2B, or S3A with seven-color extended highlighting in all terminal modes. Only Attachmate (see below) offers a wider range of emulation. Options sold separately include file transfer packages under either CMS or TSO, multiple session windowing and 3270-PC emulation, and 3279-S3G emulation (which permits full color graphics support).

The optional file-transfer package includes a diskette for the PC software and a 1600-bpi magnetic tape for the mainframe software. The documentation includes well-written installation instructions for both. The mainframe instructions are presented in an orderly fashion, but knowledge of JCL, CLISTs, ISPF (if installed), and system specifics is required. Installation of the PC software also is straightforward and, in fact, is included as one step in the general installation of the FORTE PJ emulator.

Forte offers two separate file transfer products for CMS and TSO. This

evaluation pertains only to the TSO product, TSO-Fortenet (although a Forte representative affirmed that CMS-Fortenet is similar.) TSO-Fortenet is the most powerful file-transfer package in this field. In addition to allowing both varying-length-text and binary-file transfer between the PC and the mainframe, it also supports transfer to the MVS SYSOUT and INTERNAL READER. Transfers to SYSOUT permit the user to send PC files directly to mainframe output devices such as laser printers or high-speed line printers. Transfers to the INTERNAL READER permit mainframe batch jobs stored on the PC to be submitted directly to the mainframe. The product supports both ACF2 and RACF security systems. TSO-Fortenet has only one major limitation: it will work only when FORTE PJ is running in non-memory-resident mode.

In spite of this, TSO-Fortenet offers a variety of special features. It functions in TSO's native READY mode and includes full support for ISPF with six easy-to-use menu screens. It includes a series of mainframe CLISTs for batch uploading and downloading, the most powerful of which is BACKUPHD, used to back up directly to the mainframe all the files in specific PC directories. As a result, streaming tape or any other PC-based backup systems are unnecessary.

Forte's file-transfer facility, with both mainframe and PC components, includes extensive validity checking during transfers. Its 4,096-byte block size permits a faster rate than some of the other record-oriented packages. The documentation includes descriptions of the ASCII-to-EBCDIC and EBCDIC-to-ASCII tables that Fortenet uses to accomplish all of its character translation.

The FORTE PJ emulator functions well and all of its features work as documented. When using a color graphics board and color monitor, the emulator comes up in 3279 mode without requiring the user to define the colors. The status line includes items not found on the 3278/79 line, such as a resident mode indicator, which shows if PJ is memory-resident, and a model number indicator, which shows the current emulation model. FORTE PJ uses the Shift-Shift hot key to switch between 327x and DOS sessions. Its emulator includes many of the extended features found in other packages: screen image capture to disk, local screen print, initiation of resident mode, and diagnostic tests. Users should note, however, that these extended features and file-transfer functions are available *only* in non-memory-resident mode.

FORTE PJ is one of the few emulators to provide all of the functions of a 3278/79 keyboard, including Cursor Select. With the custom configuration program FDSCONF, the user can change the model emulation, keyboard layout, video interface and monitor type specification, color, and attributes, base address, printer port, foreign country keyboard and display, extended attribute support, and PC model. In addition to the default U.S. English keyboard, FORTE PJ also supports the Austrian/German, Belgian, Brazilian, Danish, Finnish, international, Italian, Portuguese, Spanish, U.K. English, Norwegian, Swedish, and French keyboards.

This product's manual is one of the most complete. Offering detailed step-by-step instructions on both hardware and software installation, it takes the user through diskette backup and working copy generation. The system comes with standard default values for PC type,

FORTE PJ's TSO-Fortenet is the most powerful file transfer product in the field, but it runs only in non-memory-resident mode.

interrupt level, 3278/79 model type emulation, and other necessary parameters. It determines the base I/O address, video interface type, monitor type, and printer port from the motherboard DIP switch settings. Any of these parameters can be changed with FDSCONF.

The manual also has extensive, well thought out sections on diagnostics, troubleshooting, and error messages, including an excellent discussion of potential base I/O address conflicts with other boards. The package contains an installation diagnostic program and troubleshooting routines.

Attachmate 3-N-1 3270 COAX Adapter. Attachmate offers the most versatile emulation boards and software on the market. Its 3-N-1 adapter is so named because it will run not only Attachmate's own software, but also software for the IBM 3278/79 emulator board and the IRMA board. (Some features of IBM's and DCA's software are not available when running on the 3-N-1; tables summarizing supported and unsupported features are included in the manual.) The documentation indicates that 3-N-1 will run PC-Focus from Information Builders, Goldengate from Cullinet, Interactive PC Link from McCormack & Dodge, and Tempus Link from Micro Tempus. Attachmate's 3270-PC emulation software also is interchangeable with the IBM adapter and the IRMA board. The 3-N-1 adapter with Attachmate's emulation program will emulate models 2, 3, 4, and 5 of both the 3278 and 3279, thus providing the widest emulation range of all packages tested. Its only significant shortcoming is that it does not offer the 3279 graphics support available with the FORTE PJ.

The file-transfer routine, included with the package's PC 3270 Emulation Program, offers support both for a proprietary file-transfer protocol using TSO's EDIT or CMS's XEDIT (similar to LINKUP or Persyst COAX/3270) and the host-supported protocol that is available with IBM's 3278/79 Emulation Control Program and 3270-PC. IBM host programs required are number 5664-281 for CMS, 5665-311 for MVS TSO, and 5798-DHQ for CICS (MVS/VM DOS). The editor-based transfers are slow, have no validity checking, and only provide support for text file transfers; they require no additional software and no mainframe installation. The host-supported routines are fast and include extensive validity checking, but they require the additional IBM programs and mainframe expertise for installation.

The Attachmate PC 3270 emulation program offers many features beyond the standard 3278/79 emulation. Because it also emulates a 3270-PC, it can accommodate seven active windows, including four simultaneous host terminal and printer sessions, two notepads, and a PC window running DOS (any version from 2.0 to 3.1). The emulation software is always resident, and rather than using traditional hot keys to move between DOS and 3278/79 sessions, the user jumps among the seven windows using the 3270-PC-style window management keys. However, it will function at a similar level to the other products using only two active windows: one for DOS and one for the host.

Attachmate's emulator includes many other extended features, such as 3270 printer emulation (LU3 print controls for a 3287 with a 2,048-byte buffer size), screen-image capture to either disk or local printer, and data block copying between windows. Its window management commands—jump, corner, size, add, delete—are virtually identical to those for the 3270-PC.

The Attachmate software has a unique copy-protection scheme. If the

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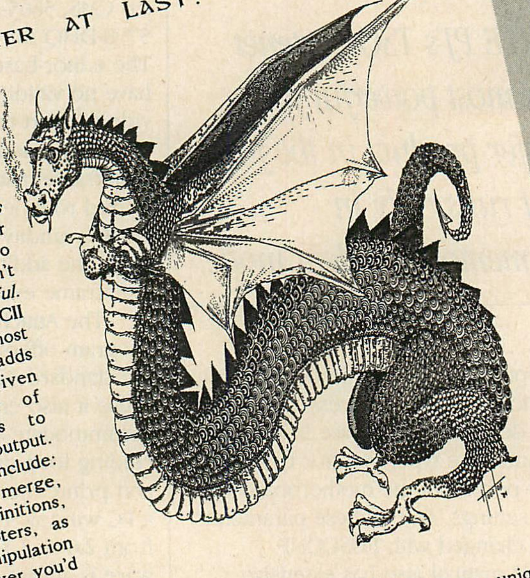

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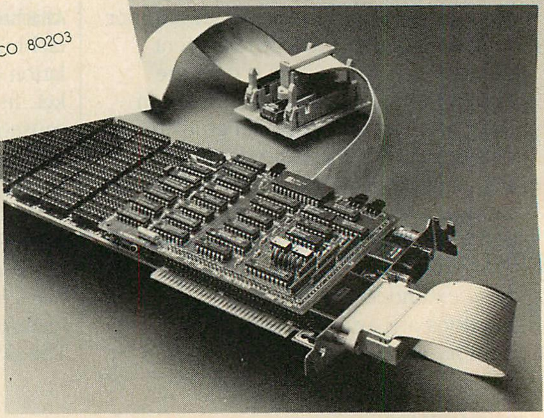

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software is being used with an IBM or IRMA board, a key disk is required in drive A:. If it is being used with the 3-N-1 board, the key is located in the firmware on the board. The 3270-PC emulation program includes an extensive configuration utility that covers many languages (U.K. English, French, Italian, Austrian/German, and Spanish, in addition to the default, U.S. English), user keyboard mapping, adapter board and host window session parameter selection, and window profiles. All 3278/79 keys are supported except Cursor Select and the fast arrow keys.

The installation goes smoothly because of complete and well-written documentation. Instructions for both hardware and software discuss I/O and memory address considerations and compatibility limitations. When emulating the IRMA board, 3-N-1 uses I/O addresses 220H-227H and memory addresses CE000-CFFFF; for the IBM board, it uses I/O addresses 2D0H-2D7H (the IBM board has no on-board memory, hence no memory mapping). The 3-N-1's I/O and memory addresses can be changed via jumper blocks.

The two manuals contain well-written sections on troubleshooting and error handling. The 3-N-1 diagnostic test program, provided with the board, lets the user verify installation and pinpoint operational problems that occur afterward. The diagnostic has both a standalone and on-line mode and tests all major functional areas of the adapter, including PC-to-adapter I/O control, shared memory, the coax processor, and the coax-peripheral interface. Attachmate's diagnostic program is the most thorough of those tested.

IRMA 3270 board. Digital Communications Associates' IRMA board, with its E78 Emulation Software, was the first 3278/79 emulator on the market. It has evolved into one of the most complete packages available. The IRMA package can emulate 3278/79 models 2, 3, and 4, which equals or surpasses all boards except the Attachmate 3-N-1.

In addition to the extended features (such as screen-image capture to disk and printer, keyboard configuration, and file transfer) offered on many boards, IRMA is the only product to provide full light-pen support. It does so through emulation of Cursor Select to simulate a light-pen selection. In addition, when the E78 terminal emulator is used with the IBM Color Graphics Adapter and a light pen (such as the pen by FTG Data Systems) is connected to the adapter, it fully emulates the IBM selector pen option on the 3279.

IRMA supports data entry to IBM mainframes through character-oriented serial devices attached to the COM1 serial port. The interface permits such options as bar code or optical character readers and touch input screens (such as the one manufactured by Touch Technology). For displays equipped with special character generator ROMs (which are available from DCA or STSC), IRMA supports the IBM APL/1 character set and keyboard.

Like 3-N-1, IRMA offers two file-transfer protocols. IRMAlink FT78X, a program that comes standard with the E78 software, uses XEDIT on the host running VM/CMS and TSO EDIT on an MVS/TSO host. It operates similarly to the editor-based file-transfer programs provided by other manufacturers, and supports text and limited binary file transfers. Editor-based transfers are naturally slow, but IRMAlink uses POWERINPUT in XEDIT to improve performance on file uploads. (POWERINPUT allows "stream" character input without waiting for prompts.) The binary mode is used for transfers from PC to PC by uploading to the host from one PC and downloading to another. Archival storage of PC files on the mainframe is done in the same way. However, the transfer of binary files that the host can recognize is *not* supported.

DCA's IRMA has evolved into one of the most complete 3278/79 emulation packages available.

The problem is that 8-bit bytes cannot be transmitted through mainframe editors, which deal only in 7-bit characters. (The high bit usually is usurped in some sort of parity-checking scheme.) PC binary files must be converted into two 7-bit characters before uploading through XEDIT or TSO EDIT. The character files stored on the mainframe are restored automatically to binary form when they are downloaded to a PC. For the mainframe to use them, a conversion utility must be written on the mainframe end to reassemble the character pairs into the original 8-bit bytes. DCA does not provide such a utility, nor do any of the other vendors employing a similar conversion scheme.

DCA does, however, bundle IRMAlink FT/TSO and FT/CMS with the IRMA board to handle binary file transfers. IRMAlink is a high-speed file-transfer software package with both micro and mainframe components. The mainframe portion is distributed via two media: diskette and 1600-bpi magnetic tape. The diskette-based software can be uploaded using FT78X; the tape-based files can be unloaded using mainframe utilities. TEST.TXT, a file that is included on the distribution diskette, tests the file-transfer function.

FT/TSO can be run using either menu or single-command format. The former makes FT/TSO menu driven and allows access to the transfer type assigned by FT/TSO and to the transfer parameters. The latter makes FT/TSO command driven, and does not allow changing transfer types or parameters.

IRMAlink FT/TSO provides for the transfer of binary and text files of varying lengths. It supports both sequential and partitioned data sets. Through the use of predefined parameters (block size, LRECL, record size, and so on) each transfer requires only a fairly simple command. The predefined parameter file can be modified via a menu screen invoked by a function key.

IRMA's E78 emulator program can be activated with four options: basic E78 program, E78 with screen-save capabilities, E78 with screen-store and recall capabilities, and E78 with both screen save and screen store. Screen save records the screen image on disk; screen store stores the screen image in dynamic memory for recall anytime while E78 is active. Once activated, E78 defaults to nonresident mode. It is switched to resident using a hot key. In resident mode, the user can switch between 3278/79 and DOS sessions using another hot key. Like other packages, E78 does not offer the screen-image save function in resident mode. However, DCA is the only firm to compensate for this by allowing the user to activate simultaneously both the resident and non-resident forms of the emulator program. In resident mode, the user simply switches to the DOS session and initiates E78 again and is in nonresident mode. (When in simultaneous mode, the emulator uses twice the amount of memory, that is, 192KB.)

IRMA's E78 software provides complete 3278/79 emulation of the U.S. English keyboard. Using the GENX utility the keyboard and screen type can be reconfigured for APL, TEXT, and DATA ENTRY ASSIST (the latter is supported by IRMA and IBM only). GENX also defines the light pen, 3278/79 model, color, COM port, and PC look-alike

patches for the 8086. IRMA does not support international keyboards.

For operations assistance, DCA's manuals are among the best. They take the user from elementary instructions for diskette duplication to an extensive technical reference outlining the board's architecture and the internal workings of the E78 software. The documentation contains BASICA subroutines for accessing IRMA's screen buffer. The board is addressed as an I/O device on the system unit bus with device code of 220H through 227H; one drawback is that these addresses are fixed and cannot be changed.

Another of the very few disappointments is IRMA's minimal troubleshooting support. The package contains no diagnostic programs and the manual devotes only three sparse pages to diagnostics, troubleshooting, and error conditions. The conditions discussed were too general, even though the discussions themselves are good.

IDEAcomm 3278. This package from IDEAssociates, Inc. includes a full-size, single-slot 3278 emulator board, emulation software, and a file-transfer package that supports MVS/TSO and VM/CMS. IDEAcomm 3278 enables the PC to emulate a 3278-2 or a 3279-S2A/S2B with eight-color support. It does not support mainframe color graphics.

The file-transfer facility, XFER, allows transfers in both directions in a MVS/TSO or VM/CMS mainframe environment. This program, as other emulators, performs transfers using the mainframe editors and therefore provides no mainframe component for validity checking. The file-transfer program is menu driven, allowing the user to select send or receive, text or binary files, record length and format, host data-set name, and PC file name.

Binary transfers are accomplished by converting each 8-bit byte into two 7-bit characters and transmitting the characters. If the remote system is a PC also running XFER, XFER will convert the two characters back into the original 8-bit byte. Otherwise, the transmitted data must be converted into binary data by a translator program (which is not supplied—it must be written by the user). As described earlier, the binary mode may be used to store PC binary files on the host for later downloads, but uploaded files cannot be used on the host itself. IDEAcomm also has a batch file-transfer facility, RUNFER, with which the user creates RUNFER.BAT, a file that contains information on multiple files to be uploaded and downloaded. This feature is helpful since the file-transfer facility is editor based and therefore relatively slow.

IDEAcomm 3278 includes some unique and excellent features. From a 3278/79 session and without switching to DOS, the user can print and display PC files, obtain a PC directory listing, and access on-line help. The emulator also supports such features as screen-image capture to disk, locally connected printers, and controller-connected printers. With this product's screen capture to disk, the screen image is captured in a single 1,920-byte file complete with all the 3278/79 screen attribute bytes. These bytes are the same as IBM's except that the second-highest order bit (bit 6) of the attribute byte is always 1.

In addition to the stand-alone non-memory-resident mode, IDEAcomm 3278 also has a memory-resident mode. This mode makes the IDEAcomm program part of DOS, thus allowing the user to switch between 3278/79 sessions and DOS using a hot key.

The software emulates a full 3278 keyboard, including Cursor Select. The configuration utility supports keyboard remapping, but does not include support for international versions. This utility also allows the emulator to simulate power off when the IDEAcomm is exited, define the printer (local or controller connected), and define the color for screen attributes.

With the IDEAcomm 3278 emulator package, the user can print and display PC files from a 3278 session without switching to DOS.

The well-written documentation made installation easy for both hardware and software. It includes extensive descriptions of the interface between the IDEAcomm board and the PC, which uses I/O ports 3E8H through 3EAH and memory address E000H through EFFFH. The structure used to pass information between the two is described, and tips are offered on writing low-level application program drivers to interface to the 3270 display on the board. The manual also discusses the BASICA support subroutine included on the distribution diskette.

The manual has several sections on diagnostic testing using software included in the package. The program is thorough and easy to use, and its documentation well written, although quite technical for the novice.

PCOX/PLUS. CXI's PCOX was among the earliest 3278/79 emulators on the market. PCOX/PLUS is a significantly enhanced version of the original product. The hardware is reduced to a half-size board, the only one tested. CXI's package is quite versatile, emulating 3278/79 models 2, 3, 4, and 5. Like IRMA and the IBM board, PCOX/PLUS supports the Entry Assist feature. It does not, however, support mainframe graphics or the PC light pen.

The control program partially emulates the 3270-PC with one host session, one DOS session, and two notepad sessions. Notepad data may be cut and pasted to other sessions or windows, and may be combined with keyboard entries. The contents of the notepad windows may be saved to disk or sent to a local (PC) printer.

CXI sells the PCOX 3270 Series File Transfer package separately. Like Attachmate's 3-N-1, the PCOX/PLUS offers support for basic file transfer based on TSO EDIT and CMS XEDIT, and an advanced protocol running on the mainframe under TSO and CMS. CXI does *not* support CICS-based file transfers.

The editor-oriented file transfer programs are easily implemented using TSO CLISTS or CMS XEDIT scripts. The basic protocol is slow, has no error checking, and does not handle binary files. Installations using ACF/VTAM support for data communications can take advantage of the default maximum record size for the TRANSFER LIMIT.

The advanced file-transfer protocol is well thought out and fast. Installation is complex and should be attempted only with the help of systems programmers. CLISTS, JCL, and some 370 source code and object code must be uploaded using the basic file-transfer routines. Modification of the CLISTSs, JCL, library, and data set names and assembly and link editing must be done in order to complete installation.

Although this advanced protocol does not follow the IBM standard, it is very versatile. It supports standard ASCII text transfers (like the basic protocol) and several other modes. The compressed mode replaces up to 64 successive occurrences of the same character by a three-character sequence: escape, count, and character. On the host, this sequence is expanded to the original string. The binary (transparent) mode transfers an exact image of each byte. The file-transfer program translates each

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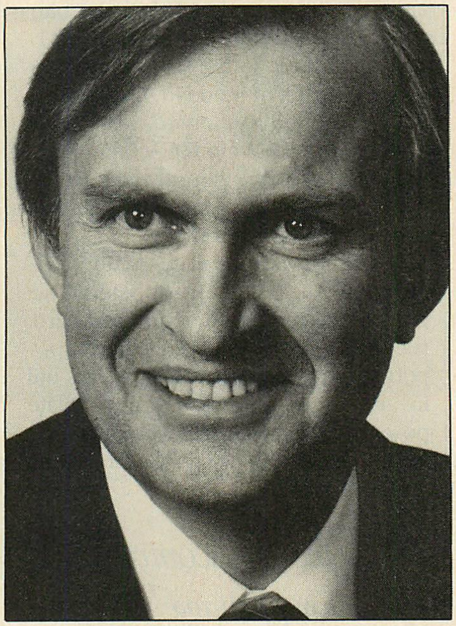

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three-byte group to four bytes of 3270 buffer codes, which are translated by the 3274/76 cluster controller (or cluster control program if in DFT mode) to EBCDIC. This is reconverted by the host-end software to the original three-byte groups. The user may specify compressed mode on this operation before three-byte translation to further speed up transfers. Finally, CXI offers an offset transfer mode for files that will be processed by ISPF. This replaces the first six or eight bytes of each record for some file types (COBOL, for example) with a sequence number.

Like many of the others, the PCOX/PLUS emulator program cannot save screen images to disk while memory resident. The advanced file-transfer package must be loaded from the host session to save screen images. In addition to interactive file transfers, PCOX/PLUS also supports command-mode transfers via PC batch files created by the CXI Batch File Generator.

The PCOX 3278/79 Control Program supports many of the 3270-PC's functions, including windows, jumping and enlarging windows, cut and paste, and changing screens. The control program functions only in memory-resident mode. Like Attachmate, hot keys for moving between emulation sessions do not apply because the software allows jumping among windows. The program supports complete 3278/79 keyboard emulation, including Cursor Select, all entry assist features, and most 3270-PC keys. CXI defines many international keyboards, including U.S. English, Austrian/German, Belgian, Canadian French, Danish, Finnish, French, Italian, Japanese-English, Norwegian, Spanish, Swedish, and U.K. English. It does *not* support user-defined keyboards.

Installation instructions are complete and the operation went smoothly. The board is factory set to IRQ level 2, DMA 1, and I/O ports 3EE and 3EF. These specifications can be changed to avoid conflicts with other boards.

The manuals are well written and offer a complete section on diagnostics. The emulation software contains a menu of excellent maintenance functions including interface reset, diagnostics, and a memory-dump facility. The diagnostics also can be accessed from the File Transfer Program.

PCOX/PLUS is a solid product with excellent file transfer and the best diagnostic functions of any board tested.

A STRONG FIELD

IBM's 3278/79 emulator has a fast, industry-standard file-transfer package and the mainframe component also supports the 3270-PC. However, because the software does an environment check, it cannot be used on non-IBM machines. In this case, the Attachmate 3-N-1 is a good alternative; it supports the IBM file-transfer protocol, runs in non-IBM compatibles, and simulates the 3270-PC as well. In configurations where slots are scarce, CXI's PCOX/PLUS could be the only choice.

Another board that deserves recognition is the FORTE PJ emulator. Although many other vendors offer better packages overall, two features distinguish the FORTE PJ: it is the *only* board that offers 3279 color graphics, and it has the fastest and most versatile file transfer program. It should be given serious consideration by the user who performs numerous transfers, who is interested in hard disk backup, or who needs to transfer files directly to SYSOUT of the mainframe's internal reader.

An evaluation such as this cannot overlook the progenitor of all 3278/79 emulators, the IRMA board. IRMA has evolved into the best board on the market overall. It supports most of the features found in the other packages and is the only board to fully support light pens. It is also one of only three that supports Entry Assist. Its file-transfer routines are solid and quick, even though they are proprietary and run only on the IRMA and 3-N-1 boards. IRMA's only other significant flaws are its poor troubleshooting and lack of diagnostic routines. However, DCA's support line was easily accessible and the personnel knowledgeable.

Emulation of 3278/79 display stations can be effected with many variations. Some users require color to support customized mainframe software; others may need or want 3279 color graphics or light-pen support. Virtually every 3278/79 feature is offered by one or more of these packages; this is a matter of selecting the combination that best answers needs. Of course, an important part of any purchase is making sure the product does what it says it will do. The manufacturing quality for each of these boards is quite high, as might be expected in a maturing microcomputer hardware market. IBM has set high standards, and because they are being met so boldly by third party vendors, users may select from among many quality products, such as the packages in this field.

Techland Systems' BLUELYNX 3270 will be reviewed in an upcoming issue.

Roger Addelson is the assistant director of academic computing at Loyola University in Chicago. He holds a bachelor of science degree in system science.

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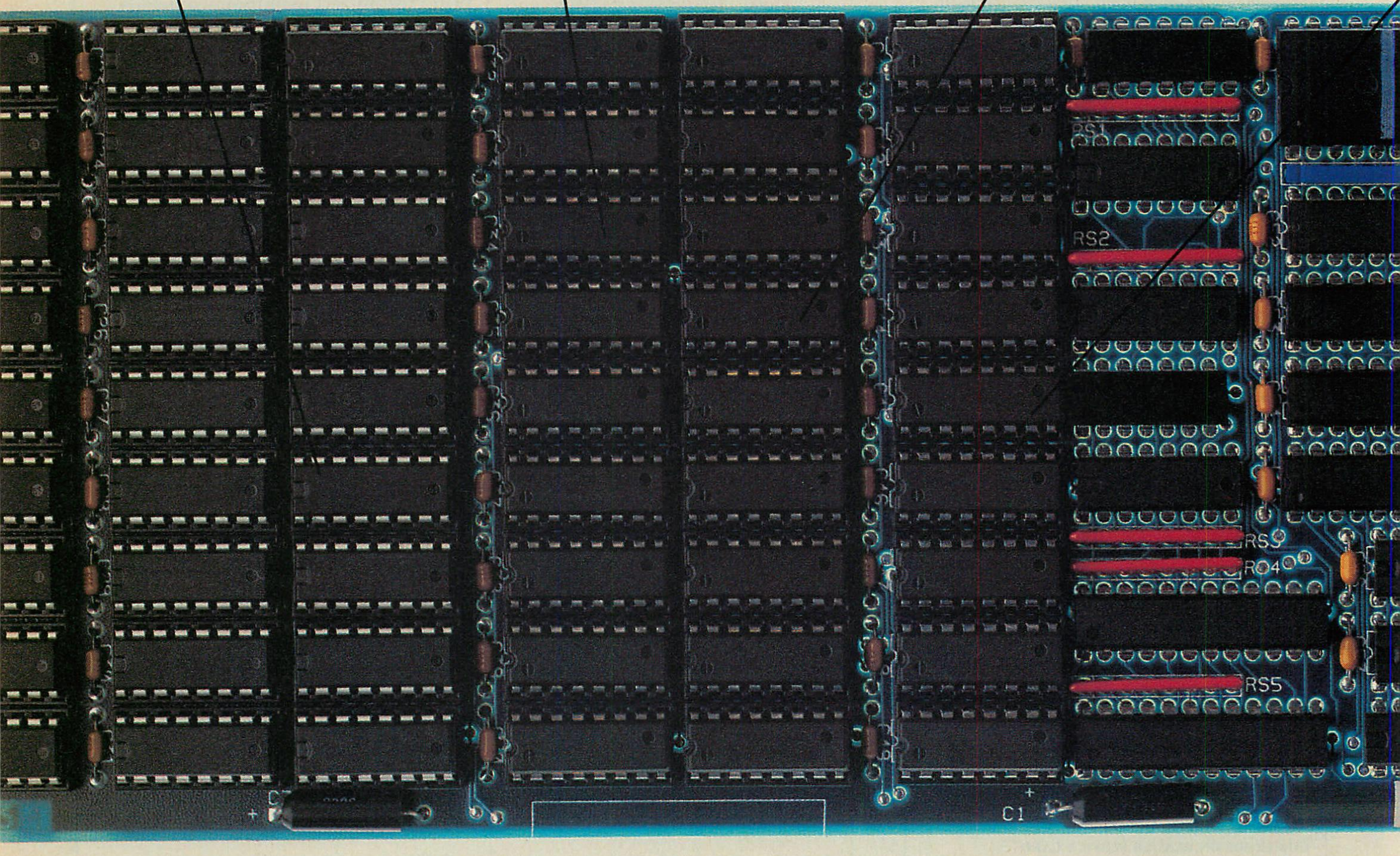

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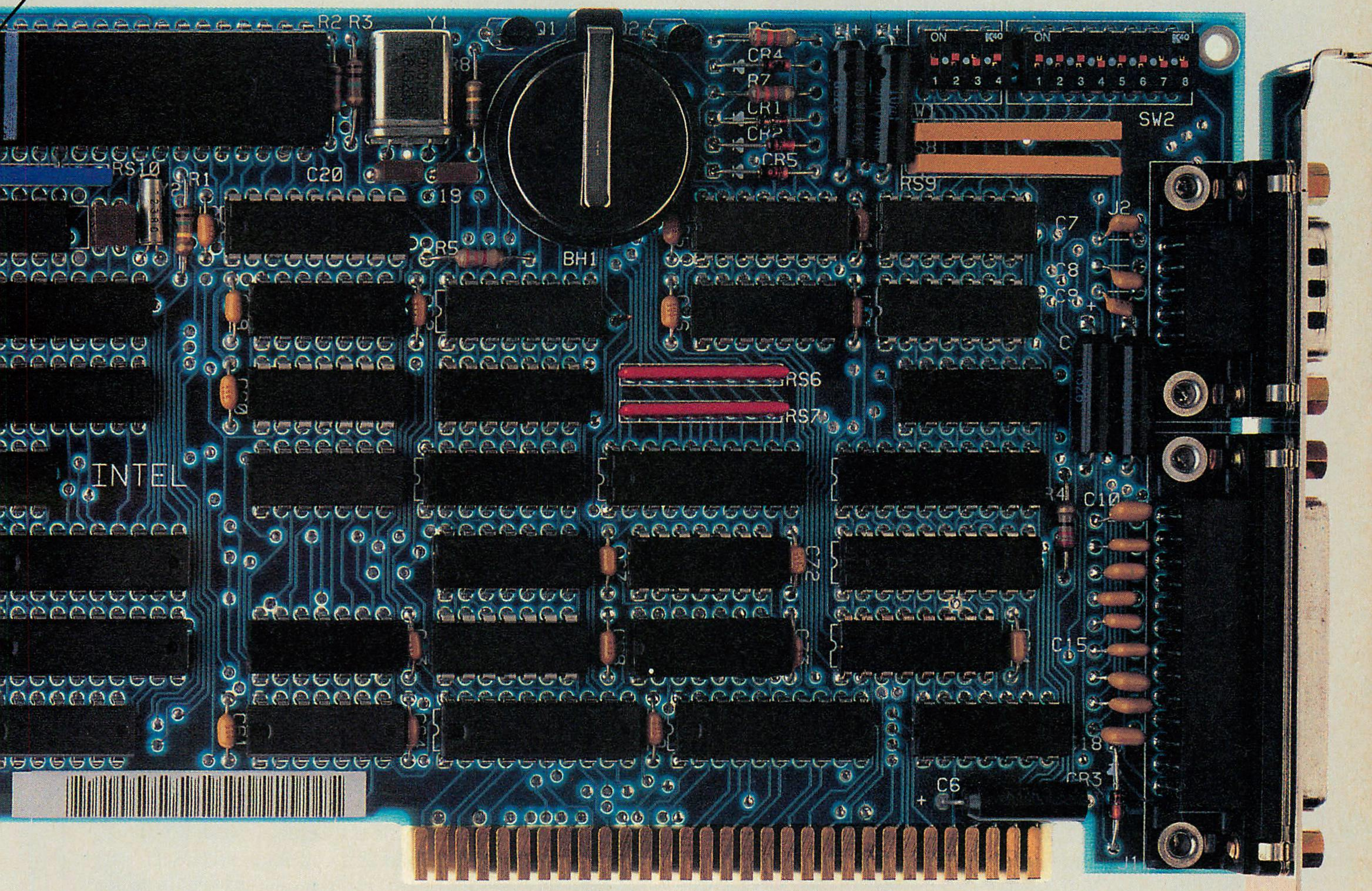

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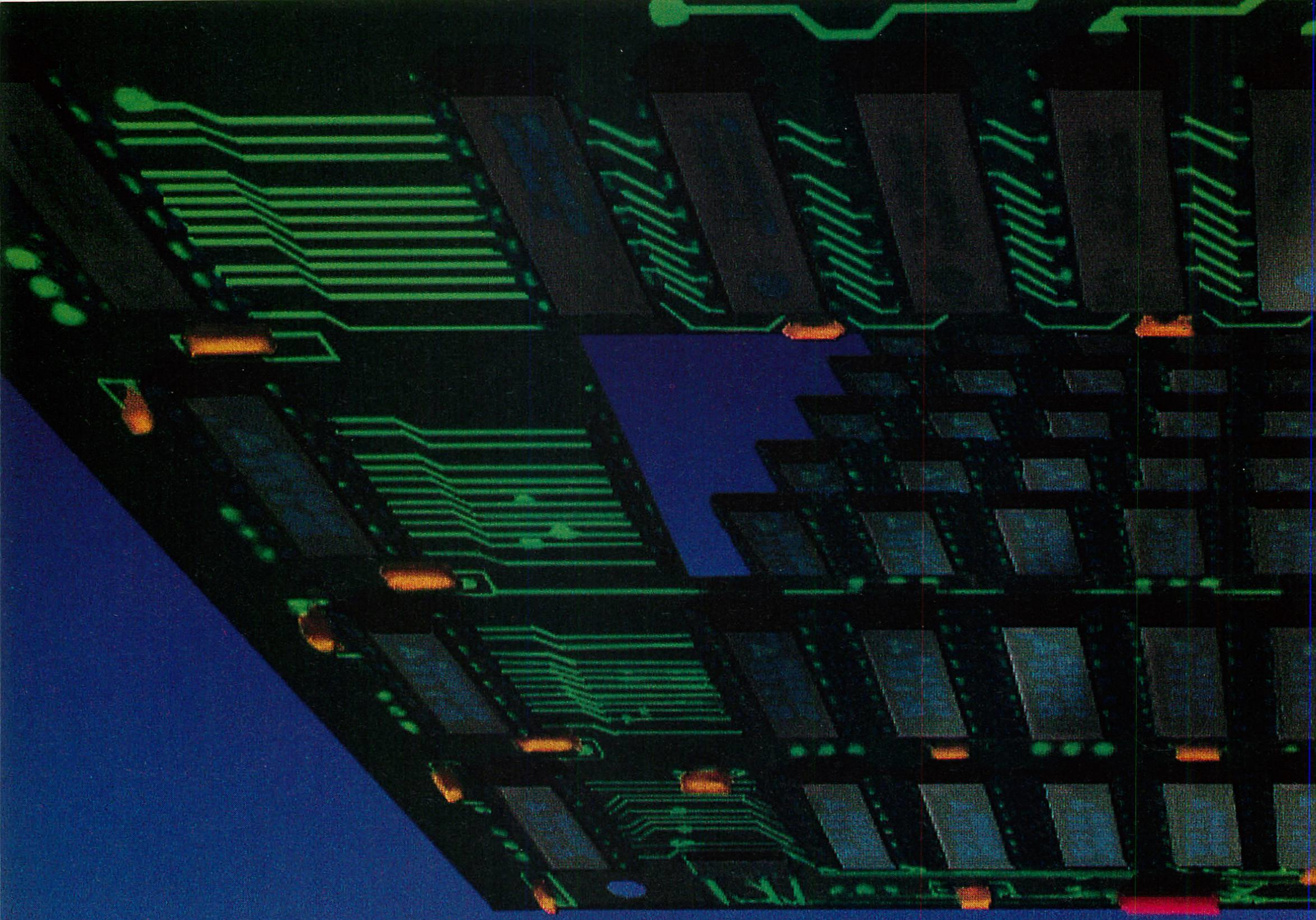


Expandable Memory

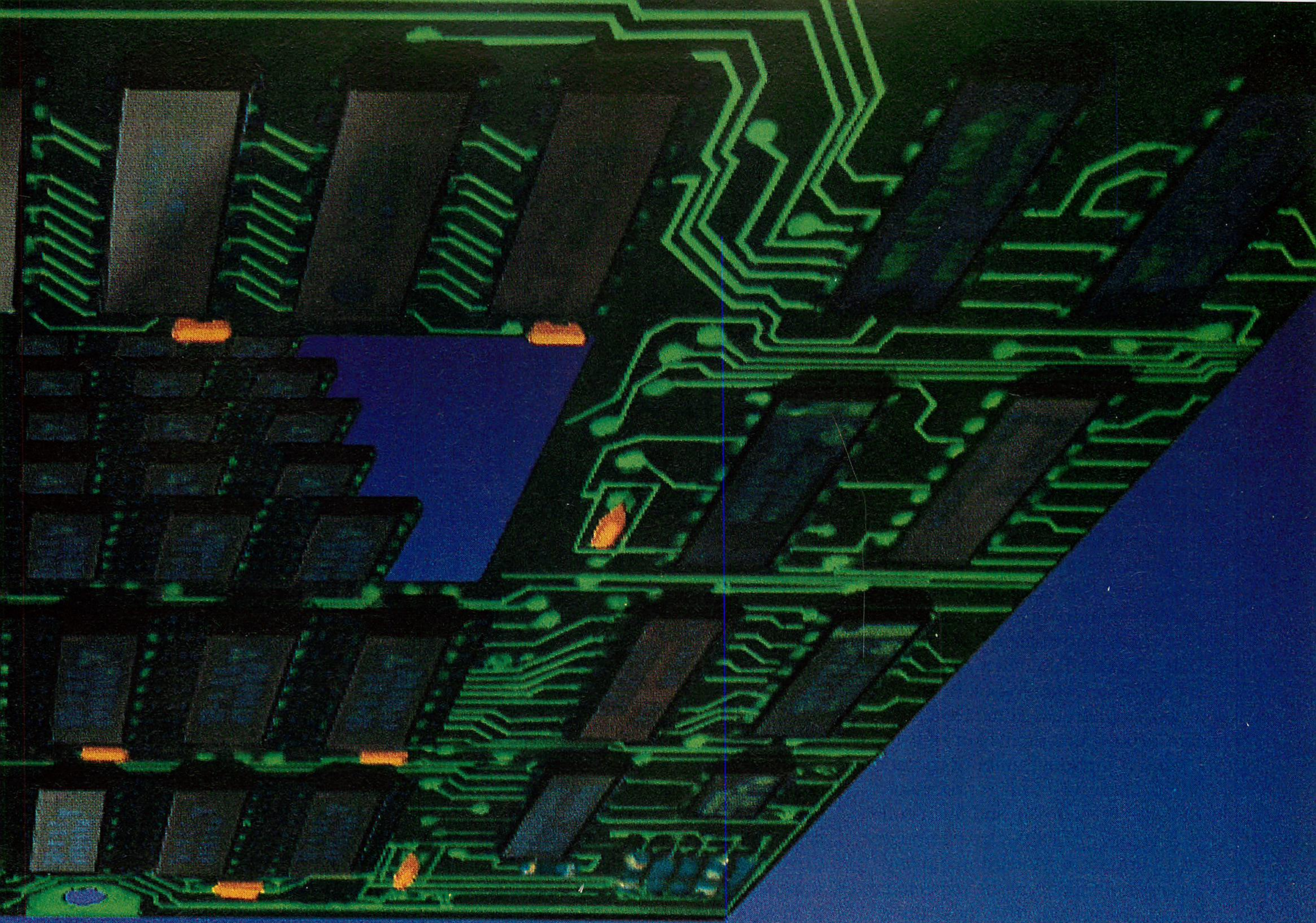
TED MIRECKI

When applied to computers, Parkinson's first law—"work expands to fill the time available for its completion"—translates into "work expands to exceed the available memory." When the IBM PC was announced, its specifications called for up to 256KB of memory. At the time, this seemed more than adequate, but IBM soon admitted that this was an artificial limit and that, in fact, 640KB was quite possible. Certainly no one would dream of using any more memory than this.

Then along came resident utilities, spreadsheets, integrated software packages, and, above all, task-switching systems such as TopView and Windows that began pushing at the 640KB limit. The PC/AT promises relief from this problem in the future, but until the debut of an operating system that runs in protected mode, that remains only a promise. In the meantime, the several million PCs and PC/XTs are stuck with "only" 640KB. Or are they?

To illustrate how the PC's memory space can be expanded, consider the memory map shown in figure 1. The 8088 processor has the capability to address up to 1MB of memory with hex addresses of 00000 to FFFFF. For this discussion, this megabyte space is defined as a collection of 16 segments of 64KB each. Individual segments are identified by the high-order hex digit of the address of any byte within that segment. Thus, addresses between 00000 and 0FFFF are in segment 0, those between 10000 and 1FFFF are in segment 1, and so on up to segment F. When the memory is populated with 64KB chips, each segment is implemented as one bank of nine chips.

In its infinite wisdom, IBM decided that 640KB, or the ten segments 0



The Expanded Memory Specification provides a standard bank-switching approach for developers to follow when they are creating software for PCs with expanded memory; two primary hardware implementations of the EMS are tested.

through 9, would be all that users would ever need. The remaining segments A through F were reserved for system use. Initially, only segments B and F were accounted for: B for video memory, F for ROM containing the BASIC interpreter and the system BIOS. Gradually, the other segments also were assigned functions. Segment C received the hard-disk BIOS, segments D and E became the home of the PC*jr*'s ROM cartridges, and segment A was assigned to the IBM Enhanced Graphics Adapter (it was always reserved for additional video memory). The system scans addresses C8000H through E0000H during the power-on self test for additional valid ROM modules. These could originate from adapter boards including the EGA or a network.

Contrary to widely disseminated wisdom, the limit of 640KB did not arise from any inherent limitation of DOS, but from IBM's design choice to lay claim to the top 384KB of the address space. On a system without an EGA, it is possible to add RAM in segment A, run a utility to tell DOS of the new memory size, and compute with all 704KB under DOS control (the TI Professional, an MS-DOS machine, is designed this way). Furthermore, if IBM had put the video memory into segment E instead of B, then a system without a hard disk could be loaded with up to 896KB (14 segments, 0 through D). The only requirements for DOS memory are that it be contiguous and not populated with ROM chips.

The seemingly haphazard sprinkling of video memory and ROM code throughout segments A through F, however, does not leave enough contiguous memory to make a useful addition to system memory. The solution is to use

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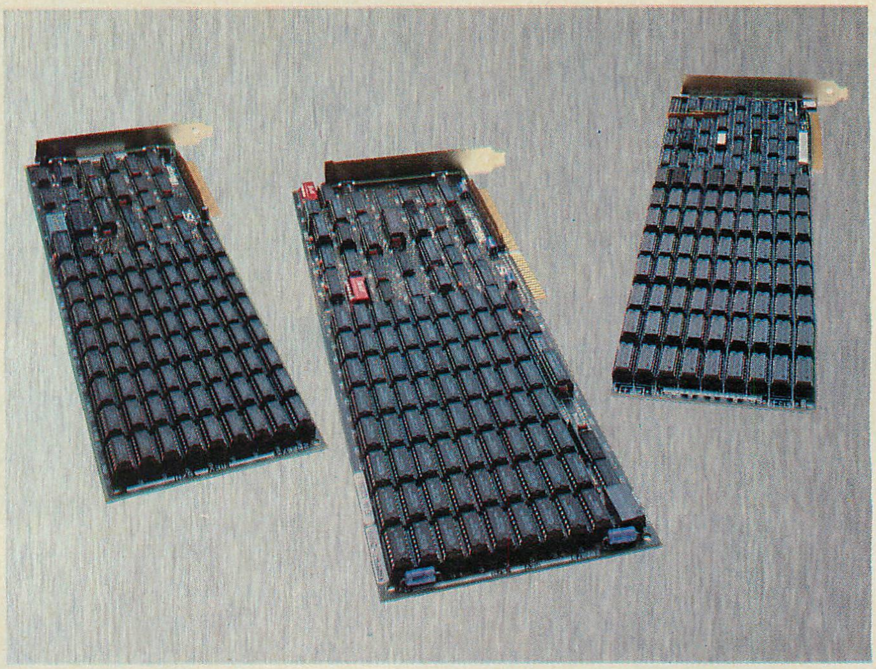


PHOTOGRAPH • PETER FORBES/BLAKESLEE-LANE

The boards can have various memory configurations. Above, left to right: the AST RAMpage! PC version, AT version, and Intel's Above Board.

bank switching, a technique long used by Apple and CP/M systems to overcome the 64KB limitation inherent in their microprocessors. Bank switching is not new to the PC; for some time boards have been available with up to 2MB, as has software that runs RAM drives and print buffers outside of the normal 640KB address space (see "Enhancement by JRAM-2," Don Awalt, *PC Tech Journal*, March 1985, p. 92).

The problem with bank switching is that, in order to make use of extra memory, programs must be specially written for a particular switching scheme, including the location, size, and number of page frames. Heretofore, no one scheme has been popular enough to attract widespread software development. The Lotus/Intel/Microsoft Expanded Memory Specification (LIM EMS) promises to change that, however. EMS has attracted so much attention not because it is a technological breakthrough, but because Lotus Development Corporation (the maker of Lotus 1-2-3 and Symphony), Intel Corporation (the manufacturer of microprocessor ICs for the PC and AT), and Microsoft (the developer of DOS), have enough clout to impose a standard that many software developers can be expected to follow. Even without IBM, these three companies represent the major forces in hardware and software in the PC world. IBM's attitude toward EMS is not known, but its pact with Microsoft for the joint development of any future operating systems is a hopeful sign that IBM does not have overt plans to torpedo the EMS efforts.

EMS was developed jointly by Lotus and Intel; Microsoft joined in later. Microsoft's interest bodes well for the incorporation of the standard into future versions of the operating system. At Microsoft's request, the latest version of the specification (version 3.2) has been enhanced to facilitate its use at the operating system level.

The LIM EMS has attracted not only support from software developers, but competition from hardware vendors as well. AST Research, Quadram, and Ashton-Tate have jointly issued their own specification (AQA EMS), which claims to be a superset of the LIM specification that offers the user more capabilities. Enhancements often have been the death of standards, but the LIM and AQA entries may be sufficiently compatible to coexist.

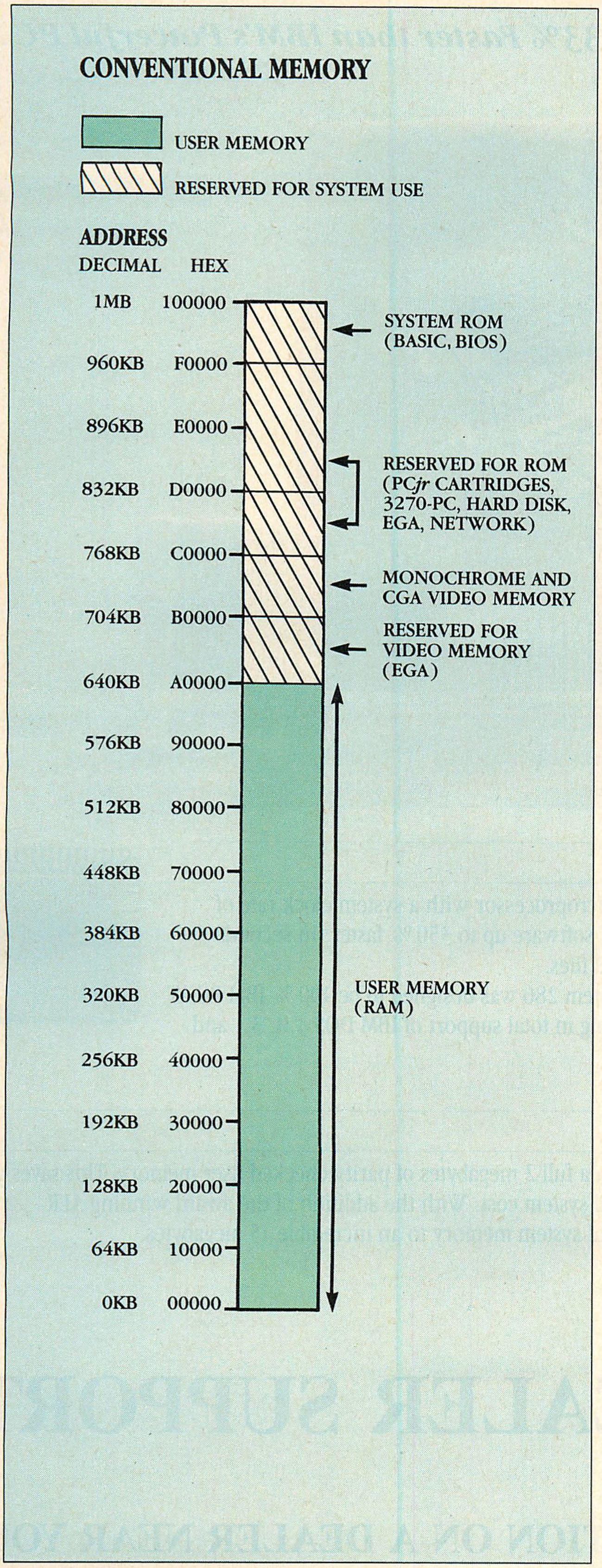
The compatibility of the LIM and AQA specifications has been improved in version 3.2. The primary incompatibility resides in the different hardware designs of the boards. But direct access to the hardware is no longer necessary, and applications may make full use of expanded memory using only the software interface that is common to both. If an AQA EMS board and its software faithfully implement that interface, they should support applications written for the LIM specification, provided the application is well-behaved according to the rules of the base specification. The converse, however, is not true: applications written specifically for the capabilities provided by the AQA specification will not run on an LIM board. Theoretically, the AQA version is more flexible, allowing better integration with the operating system, but the preferred version will be the one ultimately to run more EMS applications.

Either version of the EMS is applicable to both the PC and the AT, because it is implemented in the first megabyte of address space accessible to both machines. Why does the AT, which is inherently capable of addressing up to 16MB in hardware and several gigabytes through software, need a bank-switching scheme? Until an operating system becomes available to manage those megabytes, application programs must manage them on their own. Several possibilities exist for doing that, and some ways may be incompatible with others in coresident and multitasking implementations. In other words, standards are needed here just as they are for bank switching. If memory is to be extended beyond that controlled by the operating system, the bank-switching approach has the advantage of being applicable to the large installed base of PCs.

An important point to note here is the distinction made by the EMS between different types of memory. It uses the following definitions, the first and second of which follow IBM's usage. *Conventional*, or *normal*, memory is the 1MB of linear address space accessible to the PC and the AT in real address mode. This is subdivided into user memory (up to 640KB) and system memory. *Extended* memory is the linear memory between 1MB and 16MB accessible in the AT's protected address mode. The EMS is not concerned with this memory. *Expanded* memory is the paged memory implemented through bank switching, as described in the EMS specifications.

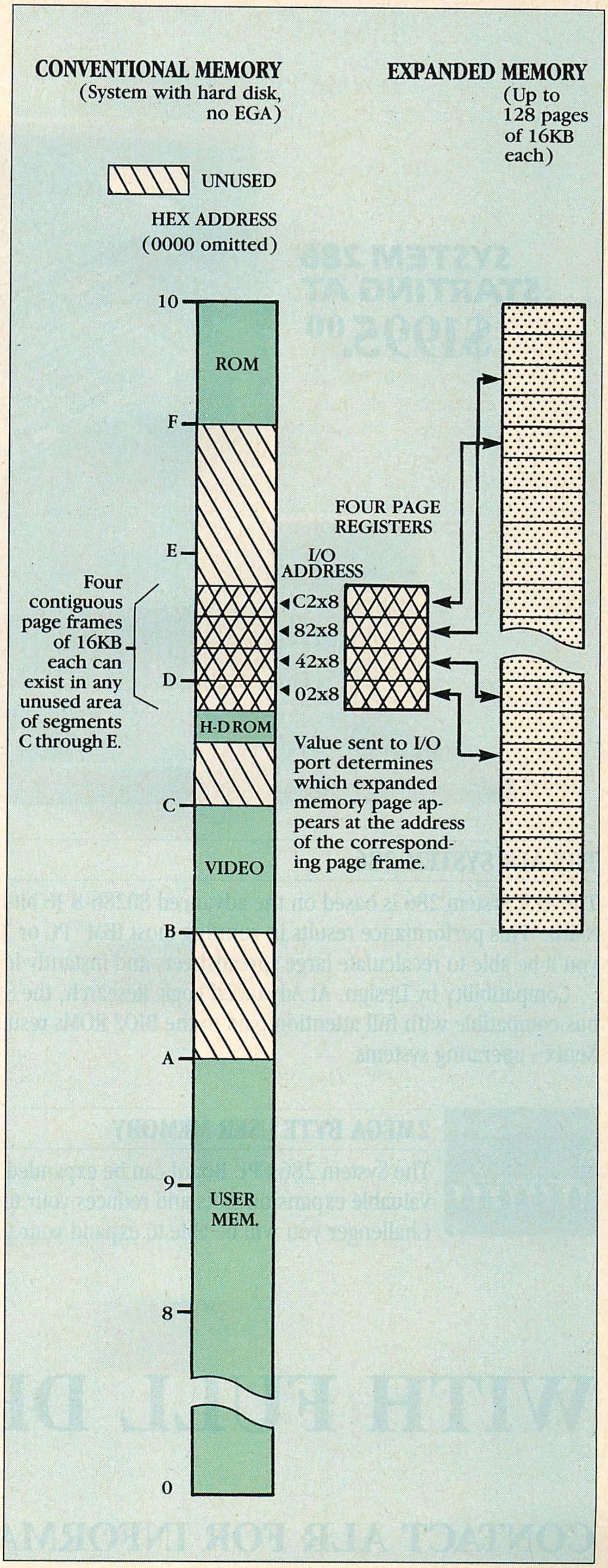
Extended memory boards have been available for the AT since its introduction, but besides RAM disks, print buffers, and the XENIX operating system, not much software exists to take advantage of them. Expanded memory boards for both the PC and the AT are now available, as is the applications software that uses them. For the AT, expanded memory boards typically provide both extended and expanded memory. The most flexible approach, implemented on some of the newer boards, is to allow switching between the two types of memory with software control rather than by hardware switches. This approach could allow the

FIGURE 1: *PC Memory Map*



The first 640KB of system memory is reserved for user RAM. The additional six segments of 1MB of addressable memory that DOS can address are reserved. However, gaps often occur that can be used by expanded memory boards.

FIGURE 2: *The LIM EMS Implementation*



The Lotus/Intel/Microsoft EMS allocates four contiguous page frames (of 16KB each) in a vacant area of segments C through E. The expanded memory page is then viewed in one of the page frames.

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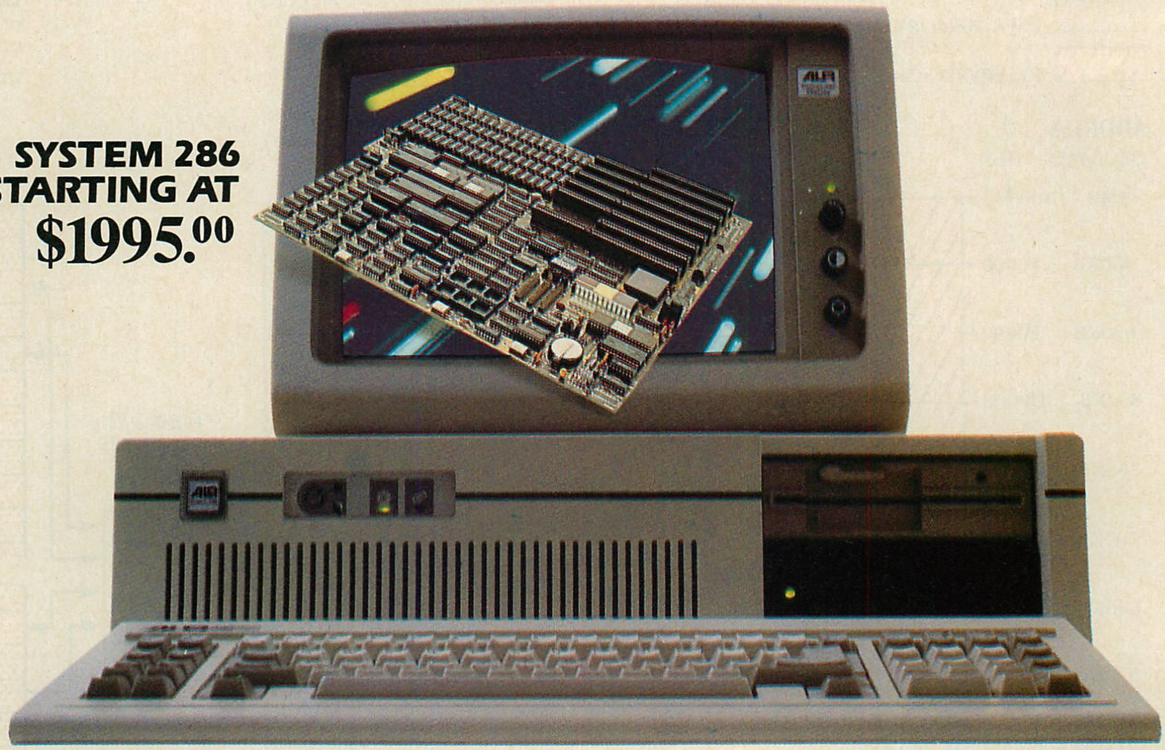

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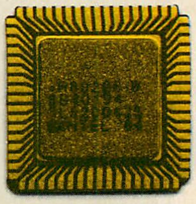

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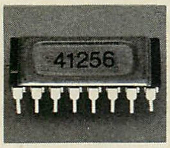

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EMS boards to become extended memory boards when a new operating system becomes a reality.

Two boards that implement the EMS, from Intel and AST, both involved in developing the specifications, will be evaluated later in this article with associated software; Lotus Symphony version 1.1, will provide an example of an EMS application. Other boards supporting the EMS are listed in an accompanying sidebar. They were not reviewed by *PC Tech Journal*.

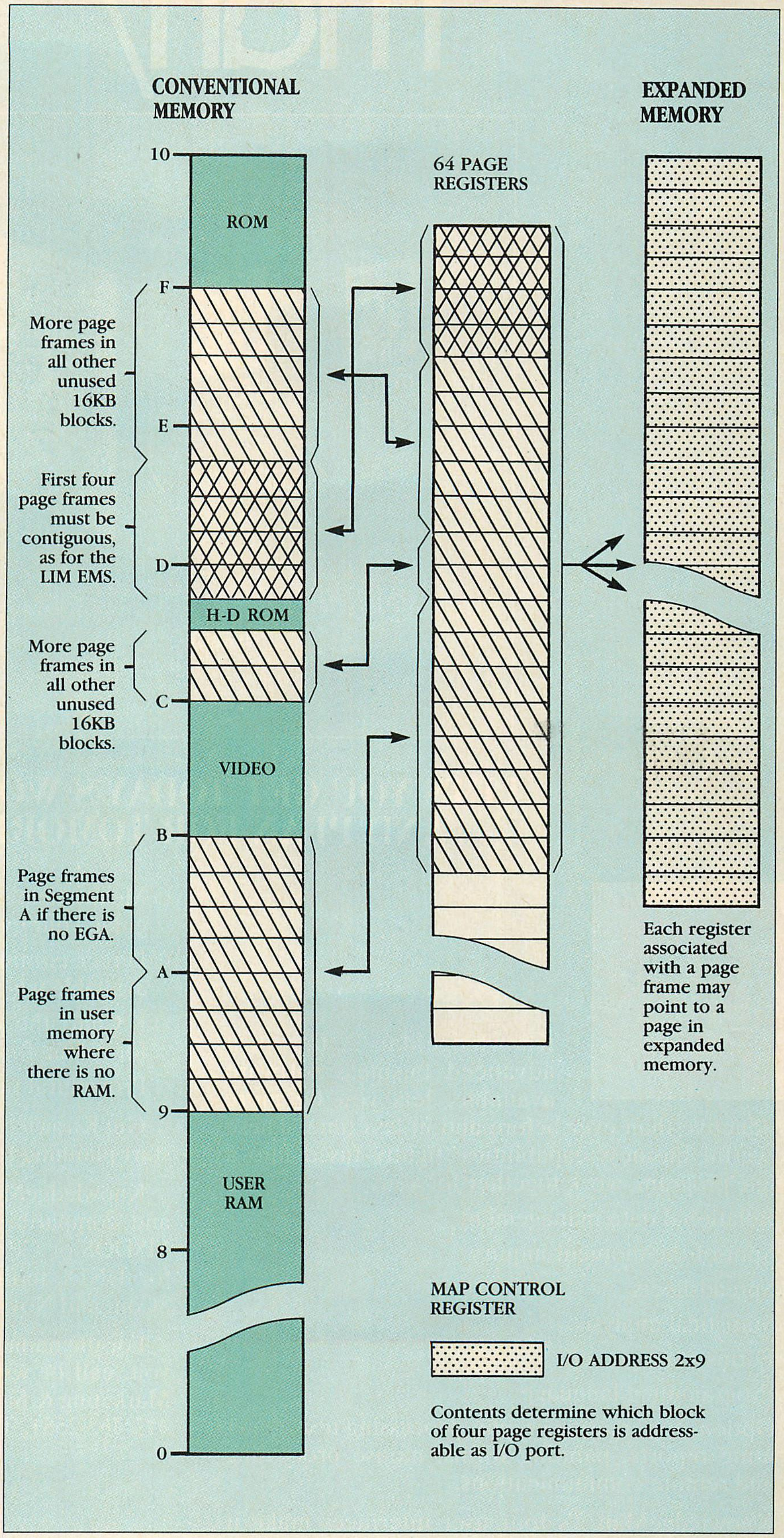
EMS DETAILS

The EMS is embodied in a specification document, available free of charge from any of the three participating companies. The document defines the functions provided by the expanded memory software and describes how to write programs that use expanded memory. Functional descriptions of the hardware and the low-level, bank-switching procedures (meant for hardware vendors), once part of the specification, have been removed from the current revision (version 3.2). The document consists of 80 pages written in the style of the DOS *Technical Reference* manual. It does, however, include more explanations and program examples than the DOS book. The layout could use improvement, but generally the information should be clear to the experienced assembly language programmer.

The EMS supports four memory boards, each with 2MB, for a total of 8MB of expanded memory. This memory is organized in pages of 16KB, with up to 128 pages per board. The LIM version has four contiguous page frames, allowing access to 64KB at a time (see figure 2). The base page frame is assigned, either by hardware or software switching, to an address in segments C, D, or E. This address must be on a 16KB boundary and at the beginning of a 64KB block free of other memory (ROM or RAM). So the first requirement for using the EMS is the availability of 64KB contiguous bytes in the system's ROM space. Even a system with every conceivable ROM-driven accessory leaves this much free, but memory boards that populate segments D and E with RAM for use by RAM drives and print buffers may cause a conflict.

The AQA EMS has 64 page frames instead of four (see figure 3). The first four are assigned to a contiguous 64KB block in the ROM space, then additional frames are assigned to all remaining, though not necessarily contiguous, 16KB blocks in segments A through E. Addresses in segment B not used by

FIGURE 3: *The AQA EMS Implementation*



The AST/Quadram/Ashton-Tate EMS conforms with the LIM EMS in that the first four page frames are the same as the LIM specification, although additional page frames can be allocated in any other unused 16KB block of memory.

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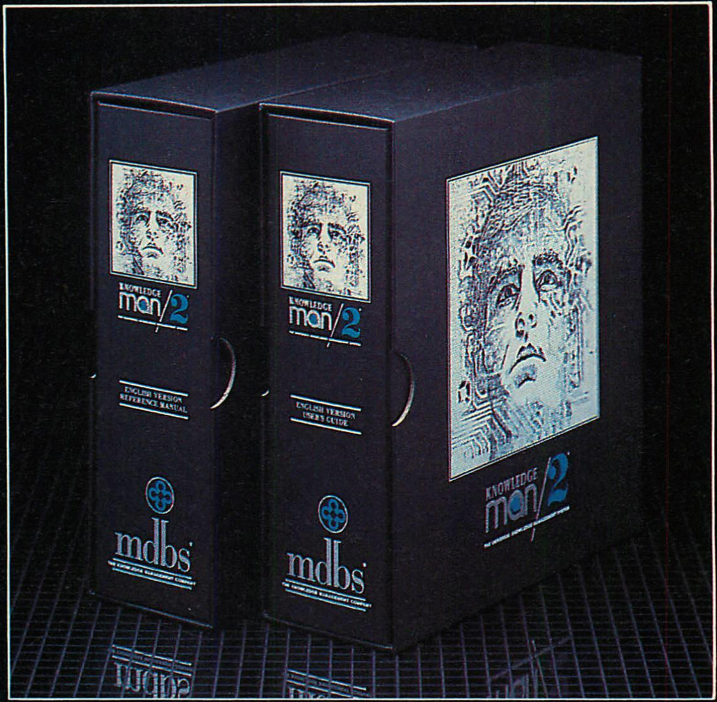

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video memory also are used for page frames. Furthermore, if any holes exist in the memory below 640KB, then more page frames also are assigned there. In practice, these will be assigned in multiples of four, because memory on the PC and AT is almost always populated with banks of 64KB.

The 64 registers allowed by the AQA specification never can be used all at once, because each register must be associated with a 16KB block of conventional memory that is free of RAM and ROM. Because 64 blocks of 16KB each exist in the conventional memory space, 64 page frames would be possible only if the system were left with no memory. The maximum number of page frames in a practical system (256KB of conventional RAM, color/graphics adapter, no hard disk, and no EGA) is 42.

Both the AQA and LIM specifications call for implementing the frame registers as four I/O ports. In the AQA version, a fifth port, called the map control register, is used to specify which 4 of the 64 registers appear in the I/O space at any given time.

The bank-switching functions themselves are performed by a program called the Expanded Memory Manager (EMM). The basic concept of bank switching is familiar to anyone who has ever installed a memory expansion card in a PC. Before the card is plugged into the system board, switches must be set so that the banks of memory chips appear in the proper places in the PC's address space. Usually, the entire memory on the board is permanently switched immediately above the memory already present in the system.

A bank-switching arrangement extends this concept by allowing only a portion of the memory to be switched into the system address space. A set of switches controls which portion is addressable at any given time. These bank switches (also known as *page registers*) are controlled by a running program. A switch that can be set by software is nothing more than an I/O port.

The total memory addressed at any one time by the microprocessor is no more than 1MB, but a portion of that memory, say 16KB or 64KB, can be used as a window into a much larger memory space. The portion of extra memory visible at one time is called a *page*, and the area within the processor's memory space where it appears is a *page frame*. The page frame may be at any address not otherwise populated by ROM or nonswitched RAM. Inactive pages, those not currently in the page frame, are not addressable by the system, but the board on which they are mounted keeps them powered and refreshed to conserve the contents.

TABLE 1: *The EMM Functions*

FUNCTION NUMBER	INVOCATION NUMBER	DESCRIPTION
1	40H	Get EMM status.
2	41H	Get the segment address of page frame 0.
3	42H	Get the total number of expanded pages and the number of available (not allocated) pages.
4	43H	Get an "EMM handle" (process ID) and allocate a set of pages to it.
5	44H	Map an expanded memory page into one of the page frames.
6	45H	Close an EMM handle and deallocate pages.
7	46H	Get the EMM version number.
8	47H	Save the current status of the EMM mapping registers (at entrance to a resident routine).
9	48H	Restore the status of the EMM mapping registers (at exit from a resident routine).
10	49H	Reserved. (Get I/O port addresses of the mapping registers.)
11	4AH	Reserved. (Get mapping of a handle's pages to physical page numbers on the EMS board.)
12	4BH	Get the total number of active EMM handles.
13	4CH	Get the number of pages allocated to a specific handle.
14	4DH	Get an array of page counts allocated to each handle.
15	4EH	Save, restore, or swap the EMM status for all handles (operating system task switch).
33	5AH	(AQA EMS only). Get an array of all page frame addresses above the user memory space.

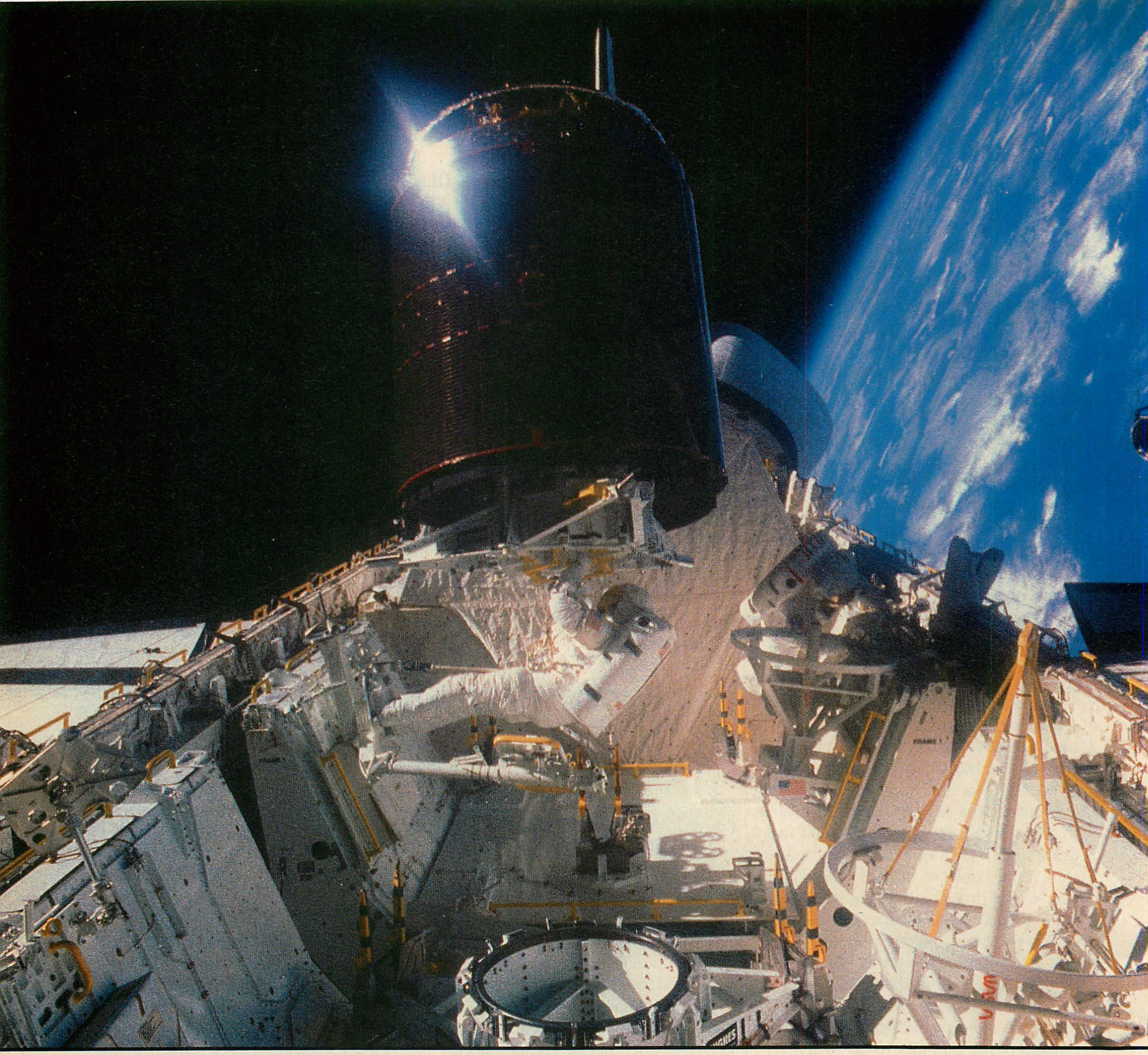
The Expanded Memory Manager for the LIM EMS has 15 functions, which are shown here with their invocation numbers and an explanation of their use. Function 33 is included in the AQA EMS only.

The significant feature of bank switching is that the contents of a memory page need not be copied into the page frame, either by the processor or by a DMA channel. A page appears in the frame as the result of writing a single 8- or 16-bit value to an I/O port. This makes bank switching even more efficient than a RAM disk, because with a RAM disk, data must be physically copied as if they were being input from external storage.

The EMM is installed at system boot time as a DOS character device driver, but it implements only two of a driver's functions: initialization and status reporting. Applications using the EMM request all other functions not through DOS function calls, but through interrupt 67H. Therefore, a requirement for using the EMS is that no other program use this interrupt. Use of this interrupt number is not a good choice, because this series of interrupts is meant for applications, not utilities performing low-level functions.

The functions performed by the EMM are listed in table 1. One of the problems with the readability of the specification document is that the functions are identified by number as given in the table, but the values that are placed into the AH register to invoke each function are different (40H for function 1, 41H for function 2, etc.). The function numbers are displayed at the top of each page, but the invocation values are buried in fine print.

Some functions are holdovers from the previous version, left to maintain compatibility with applications written for the earlier implementation. For example, the Get Status function is no longer useful, because it tests whether or not the EMM was busy servicing a previous request. The current version is partially reentrant and partially noninterruptible, so it never returns a busy status. This makes it more readily usable by both interrupt service routines and multitasking operating systems.



The use of the EMM functions is best illustrated by the following sequence of operations that a nonresident application program would use in order to access expanded memory. These operations do not include the AQA enhancements.

1. Determine if the EMM is installed. Two methods for doing so are outlined in the specification: opening the EMM device and inquiring as to its status, or looking for the device name at a fixed offset in the segment pointed to by the INT 67H vector. If the EMM is not available, the program may either terminate with an error message or continue execution in normal memory mode.
2. Function 7 determines the EMM version number to ensure compatibility with the program's requirements.
3. The total and unallocated pages of expanded memory can be determined with function 3.
4. Function 2 determines the base address of the page frames. The returned value is the segment address of page frame 0; the paragraph addresses of page frames 1 through 3 are at base plus 400H, 800H, and C00H, respectively.
5. Function 4 is used to allocate a number of pages to the program. The function returns an EMM *handle*, or identifier, for the set of pages allocated. (This terminology was added by Microsoft to version 3.2. Previously, this was called a *process ID*. The specification recommends that a program call this function once, to obtain as much memory as it needs, but nothing prevents it from calling it repeatedly to obtain more memory as needed. Each invocation returns a new handle number.
6. Function 5 maps an expanded memory page into one of the page frames. This function would be used most often in the course of execution. Pages are referenced by handle and page number within the handle. Memory within each mapped page may then be accessed by an offset from its own frame base (16KB maximum) or from the base of frame 0 (64KB maximum). When a new page is mapped into a frame, the contents of the page previously residing there are inaccessible but not lost.
7. The program must keep track of which page (and which handle, if there is more than one) contains which data. Ordinarily, tables that are in normal memory are used to point to the page locations of data in expanded memory.
8. At termination, function 6 is used to deallocate the pages for each handle obtained by the program. Pages are not freed automatically and remain unavailable to subsequent programs unless specifically deallocated.

The contents of expanded memory are not restricted. Both data and programs may be stored there, and programs may be executed from expanded memory, provided that they are appropriately written to perform the page swapping when references cross page boundaries. However, the DOS loader (which is the EXEC function) will not load a program into a page frame in the ROM space; a customized loader has to be written.

The EMM may be used by resident programs such as DOS device drivers, RAM drives, print buffers, and taskswapping utilities of the TopView type. A resident program could allocate a set of expanded memory pages at installation time, following the procedure outlined in steps 1 through 4 above. It could even load part of its code into expanded memory, so that it does not take up space in normal memory.

The EMM may be used by resident programs such as DOS device drivers, RAM drives, print buffers, and taskswapping utilities of the TopView variety.

Two functions, 8 and 9, are provided especially for use by resident programs. When a resident program is invoked, the portion residing in normal memory saves the EMM state (using function 8) because the invoking program also may be using the EMM. Once the state is saved, the page set of the resident program is mapped into page frames. Data then may be moved to and from expanded memory, or a branch may be taken to code in expanded memory. Before exiting, the resident program restores the state (using function 9) so the invoking program may resume. Thus, the use of the EMM by interrupt-driven utilities is transparent to the programs requesting their services, because the contents of the page frames are the same before and after execution of the interrupt.

The area where the status information is saved is not addressable by programs. The number of save areas per EMM handle—therefore the number of times each process may be reentered—is not stated in the specification.

Function 15 provides a more comprehensive save/restore capability. It saves in program memory the mapping information for all EMM handles, not only for the one that is currently active. This function was added in version 3.2, presumably at Microsoft's request, and is meant to implement task switching in future multitasking operating systems. It can be useful even under current versions of DOS, however. For example, by allocating the save area on a stack, a program using function 15 could be made reentrant.

The two reserved functions 10 and 11 provide lower level access to the mapping hardware. Using them, any expanded memory page can be pulled in, regardless of its allocation to any process, bypassing the memory management functions of the EMM. These two functions were placed on the reserved list in version 3.2 because they are incompatible with the new support for resident programs and multiple tasks, but they are maintained for compatibility with programs adhering to version 3.0 of the specification. Such programs, however, might not coexist with those that take full advantage of the status-switching functions.

Functions 12, 13, and 14 are meant for EMM maintenance and for utilities that report on expanded memory usage. They are useful with boards that allow switching memory between expanded and extended modes, disallowing the switch when expanded memory already has been allocated.

Function 33, available only in the AQA enhanced EMM, fills a memory array with the addresses of all page frames above the 640KB user area. The first entry in the array points to the same address as returned by function 2, and the first four are guaranteed to point to the contiguous block that is the equivalent of the four page frames defined by LIM. The addresses of any page frames in user memory below 640KB are not returned, but they may be determined by manipulating the map control register and reading the various page registers. Because direct access to the hardware is not recommended by the current EMS specification, some manufacturers are developing functions to provide software access to the lower page frames. The significance of allocating page frames in user memory is that,

potentially, this memory could be managed by DOS. Therefore, these new functions will be intended for use by the operating system, because applications should not perform bank switching of memory that could be under DOS control.

One potential problem with the AQA specification is the assignment of page frames in segment B, the one reserved for video memory on monochrome and color/graphics adapters. When expanded memory is mapped into these page frames, programs that test for the existence of a particular adapter by writing to this memory will fail, possibly crashing the system, or worse, damaging a monochrome monitor. One example is the DOS MODE command. AST's RAMpage! board (which is reviewed below), however, allows for excluding specified blocks of memory from the page mapping.

The EMS functions are obviously meant primarily for assembly language programming, but expanded memory can be used from a high-level language. The compiler must provide two capabilities: the ability to issue software interrupts (either directly or via an interface to assembly language routines) and the use of far pointers to any address in the 1MB conventional address space. Turbo Pascal and Lattice C provide these services; BASIC could be used with some arcane programming tricks.

FIRST IMPLEMENTATION

Intel's Above Board was the first hardware implementation of the EMS. It is a full-length board containing memory only (no ports or clock), with sockets for eight banks of chips. When populated with 256KB chips, that adds up to 2MB. It also may be filled with 64KB chips for a total of 512KB.

Two versions of Above Board are available—one for the PC and one for the AT. Above Board PC does not allow mixing of 64KB and 256KB memory chips; a hardware switch must be set to indicate one or the other. Other switches specify the amount of memory on the Above Board and whether any part of this memory is to be used to fill out the normal memory space to 640KB. The system must have at least 256KB already installed before Above Board can be added.

Above Board AT can fill out normal memory to 640KB (provided the system starts out with 512KB) and can provide both expanded and extended memory in a variety of combinations. The combination must be set by switches at the time of installation and may not be changed by software. The board may be populated with a mixture of chips, but the only valid combination is 64KB chips in the first two banks and 256KB chips in all others—and then only if 128KB of normal memory is being added to the system. For some reason, even if two Above Boards are installed in an AT, the system is limited to 6.5MB of extended memory. Up to 8MB of expanded memory, however, can be added on both the PC and AT.

The AT version of Above Board can accept an optional piggyback board that doubles the memory to 4MB; the PC version does not have this option. The add-on board is, in effect, a second board with its own switches for memory size and port addressing. The advantages are that it saves a slot and is less expensive than a second board; nevertheless, it is a tight fit in the AT's close slot spacing.

With the exceptions of the abovementioned differences, the boards for the PC and AT are functionally identical, and all descriptions that follow apply equally to both.

One potential problem with the AQA specification is the assignment of page frames in segment B, the one reserved for video memory on both monochrome and color/graphics adapters.

The page registers are implemented as eight I/O ports, but they take up only two port addresses in the PC's I/O space. How this bit of magic is accomplished is explained in an accompanying sidebar. The ports are addressed at 2x8H and 2x9H, where *x* is any hex digit set by the user on four switches. Some of these 16 possibilities represent addresses already reserved by IBM, and the manual lists seven recommended settings in order of increasing probability of conflict with other devices. If more than one board is used in a system, each must have the page registers at a different address.

The address at which the page frames appear need not be set by switches; this is specified by a parameter on the DEVICE statement in the CONFIG.SYS file. As described below, this line is added to CONFIG.SYS by the installation program, but it may be changed by the user.

Installation is no more difficult than for a normal memory board, although the documentation could stand some improvement. The program disk that is supplied by Intel contains an installation program, the EMM.SYS device driver, and two versions each of RAM disk and print buffer programs. The 107KB installation program needs to be run immediately after installing the hardware. It is entirely menu driven. It presents a list of most commonly used software (1-2-3, Symphony, Framework, dBASE, WordStar, among others) and suggests recommended memory configurations for several combinations of these applications. In addition, the user may specify exactly how to divide up the available memory between RAM disks, print buffers, and program memory. The end results of the installation process are new CONFIG.SYS and AUTOEXEC.BAT files, with appropriate lines added. The former contents of these files are maintained.

In addition, the installation program determines the location of the page frames in the system's ROM space and checks that the port addresses set on the board's configuration switches are indeed free of other devices. The page frames are placed on a 16KB boundary at the lowest available 64KB block in the range C400H through E000H on the PC, and C000H and D000H on the AT. The installation process must be repeated if new adapter cards containing ROM code or I/O ports are added to the system.

The EMM.SYS device driver provides all the expanded memory functions through interrupt 67H. It occupies a very reasonable 4KB of memory and adds what seems to be an interminable 26 seconds to cold-boot time, but only an insignificant 3 seconds to the keyboard reset time (provided that short diagnostics are requested by the appropriate command line parameter).

Intel's EMM implements one save area per process for the save and restore functions (numbers 8 and 9). A program that uses these functions cannot be reentrant, but with the availability of function 15, this is not necessarily a major problem.

Two bugs were discovered in Intel's implementation of EMM function 14, which fills an array with all active EMM handle numbers and the number of pages allocated to each. These have been confirmed by Intel, which is offer-

ing a new release to current owners. First, if no processes are using the EMM, then the function returns a nonzero process count (the array is not written to). The true length of the array must be determined by function 12, which returns only the active process count and works reliably. An alternative method of obtaining the correct count is to clear register BX to 0 before invoking the function call.

Second, function 14 does not clear the direction flag before filling the array, so if the flag is set when the function is invoked, the array is filled backwards from the specified starting address, destroying the contents of the preceding memory. Programs must clear the direction flag with the CLD instruction before invoking this function.

The RAM disk program is supplied in two versions, for systems with and without expanded memory. Both are implemented as DOS device drivers. The resident portion is less than 800 bytes, comparable in size to DOS's VDISK. QUIKMEM, as Intel calls it, is not as flexible as VDISK, because the disk parameters are not under the user's control. The sector size is fixed at 512 bytes, and the maximum number of root directory entries is always 128. The number of sectors per cluster (allocation unit) is one for RAM disks up to 1MB, and two thereafter. These values are reasonable for RAM disks of more than a megabyte, but they waste space for smaller sizes. Generally, QUIKMEM works well, but VDISK is preferred for RAM disks in normal memory or on an AT with extended memory.

The print buffer program, QUIKBUF, also comes in different versions for systems with and without expanded memory. Both are resident programs installed by a DOS command or from the AUTOEXEC.BAT file, not from CONFIG.SYS; the resident size in normal memory is a fat 10KB to 11KB. QUIKBUF takes over the print screen interrupt. When Shift-PrtSc is pressed, a printer control menu appears on the bottom two lines of the display. It offers the choice of pausing, resuming, or canceling printing, resetting the printer, ejecting a page, or printing the screen. In the last case, the original contents of the screen are printed, not the menu. However, if printing is in progress when a screen dump is requested, the screen is not queued at the end of the buffer, but printed immediately, set off by blank pages.

On systems with more than one printer, the buffer is not assigned to a printer at installation. It becomes associated with the first printer to which output is sent, but screen dumps are always sent to LPT1.

QUIKBUF has several problems. Some are merely annoying inconveniences: the menu requires pressing the Enter key even though the menu choices are single digits; the length of text waiting to be printed cannot be determined; and in BASIC's SCREEN 1, the menu is almost unreadable.

More serious is that in most cases the buffer does not accept output when the printer is off-line; this should be one of the major functions of this type of utility. The only program that succeeded in sending output to a dead printer was IBM's Professional Editor. All other attempts (the DOS COPY command, Lotus spreadsheets, and several word processors) failed with "Printer not ready" errors.

QUIKBUF's worst flaw is that, at installation, the type of display adapter must be specified as a command line parameter: monochrome, CGA, EGA, Hercules graphics card, or other. In the last case, the menu is not available. The documentation warns that physical damage to the monitor may result if the wrong type is entered. This is unacceptable, because forgetting the extra parameter is too easy (remember, QUIKBUF may be installed interactively from the DOS command line, not only from a batch file). Many programs present pop-up menus (SideKick, ProKey, Spotlight) without being told the type of monitor and without endangering the hardware. Above Board users would do well to obtain another print buffer program that supports EMS.

Installation of Above Board is no more difficult than it would be for a normal memory board; however, the documentation could stand some improvement.

The contents of the Above Board documentation indicate that Intel is new at marketing to consumers and does not know its audience. For example, the manual states, "If you aren't familiar with RAM disks, attach a paper clip to this page and turn to Chapter 4. When you finish, turn back to this page." The manual contains a lot of such chaff, which makes the significant information difficult to locate.

Another slim booklet, *Hacker's Guide to Installing the Above Board*, errs in the other direction: it is terse. It gives the experienced user useful information, such as no-nonsense instructions on setting configuration switches and how to set up the command line parameters without going through the installation menus. These parameters control the location of page frames, whether full or abbreviated diagnostics are performed on a keyboard reset, and the sizes of the RAM disk and print buffer. The information in the two booklets is certainly complete, but locating it is somewhat of a chore.

ON A RAMPAGE!

Like Above Board, AST's RAMpage! is a full-length, memory-only board carrying up to 2MB of 256KB chips; 64KB chips are not supported. Given the intended use of this board and the fact that 256KB chips are more economical per byte than the 64KB variety, this is a reasonable design choice. Configuration switches may be set to fill out the normal memory to 640KB, regardless of the amount of RAM that has already been installed in the system.

The AT version is also limited to 2MB per board; no piggyback is available. It may be used to fill out normal memory and to add both extended and expanded memory in various combinations. Once set, the combination cannot be changed by software, but AST provides an alternative: a program that simulates extended memory (the memory addressable in the protected mode of the '286) in expanded memory.

Installation is simple, requiring only the setting of the starting memory address (to determine whether or not conventional memory is being added) and the address of the I/O ports. The port addressing is the same as on the Intel board: seven possibilities, each taking up two port addresses in the 1KB I/O space. No installation program is included, so the user must make the changes to CONFIG.SYS and .BAT files by following the instructions in the manuals or using the several examples provided on disk. Moderately experienced users will probably prefer this method because it provides more control over the available options.

The expanded memory driver, called REMM, takes up a whopping 33KB of memory. If installing Intel's driver adds a long time to the cold-start time, installing this one seems to add

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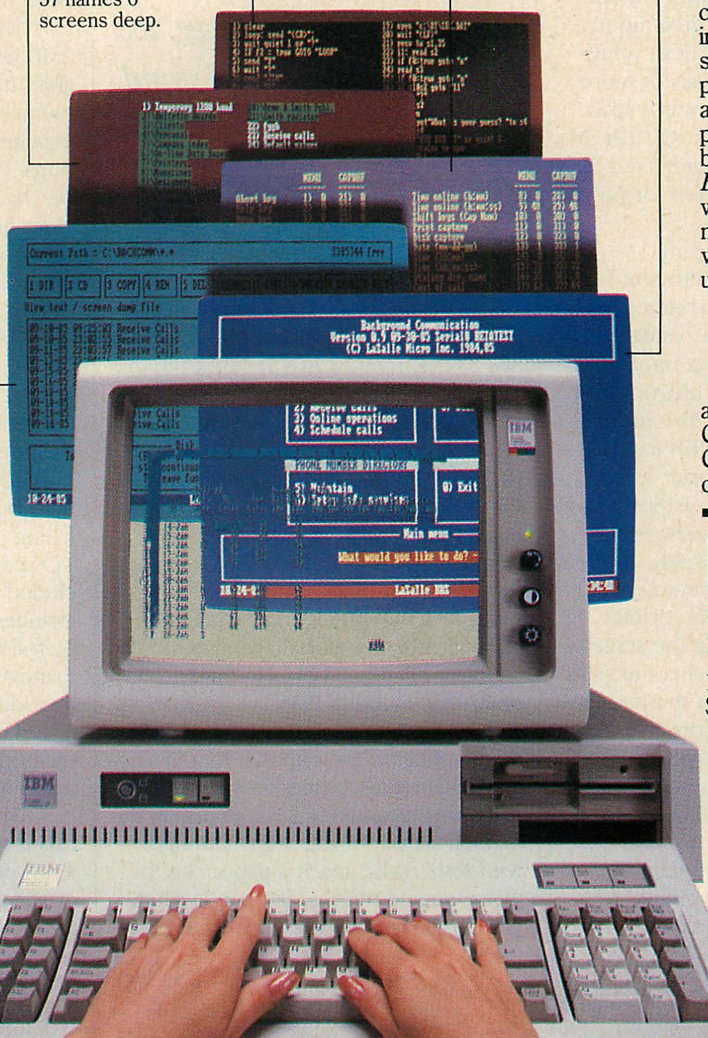

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an eternity: 1 minute 20 seconds. On a keyboard reset, however, REMM can be installed in less than 2 seconds.

REMM has a process to save multiple contexts with function 8. By default, the nesting limit is 5, but a limit of up to 32 may be specified when the device driver is installed. This allows writing reentrant interrupt service routines, but as explained previously, the availability of function 15 makes this feature less necessary than it was under the previous version of the EMS.

Other installation options may be used to control the starting address of the page frames and to keep page frames out of specified blocks of memory. The user should disallow page frames at segments B000H through BC00H, where presence of memory implies the use of a particular type of video adapter. Additionally, the total number of processes that can concurrently use expanded memory may be limited (the EMS allows up to 256; the default limit for the RAMpage! is 32). The documentation does not explain what advantage, if any, is gained by the user limiting the number of processes.

The implementation of function 33, which fills an array with the addresses of all the page frames above 640KB, has a bug similar to the one in Intel's function 14. If the direction flag is set when the function is invoked, the data are placed in memory backwards from the array's starting address. The user must clear the direction flag with the CLD instruction before every invocation.

The REX device driver program is an extended memory emulator that allows simulating the AT's extended memory in expanded memory. It can even do this on a PC, allowing VDISK to be installed with the /E option. REX is installed as a resident EMM process with a specified number of pages allocated to it. These pages then become unavailable to other EMM processes until the system is rebooted. It provides the INT 15H BIOS services that the AT uses to move data between conventional and extended memory, except that paged expanded memory is used instead of extended memory. REX is the only program supplied by AST that can use the expanded memory manager directly. All other utilities are written to use extended memory, so they need REX to provide the interface to expanded memory.

AST supplies new versions of its venerable SUPERDRV RAM drive and SUPERSPL print buffer programs. These are the AT versions that can use extended memory, so they need the services of REX to run in expanded memory. Because SUPERDRV emulates a floppy disk, it is limited to 360KB and requires the setting of system board switches to indicate an extra diskette drive. It is not very useful on a system with expanded memory. Fortunately, another RAM drive program, fASTdisk, is implemented as a device driver and can therefore support larger RAM disks. It seems to be a clone of VDISK (the installation parameters are the same) and works in much the same way.

SUPERSPL is not the best print buffer in the world, but its wide distribution indicates that many users are familiar and comfortable with it, and it is preferable to Intel's QUIKBUF. A new SUPERSPL feature allows the user to control output to the printer by the printer interrupt, instead of by the timer. But for this to work, the printer port must be initialized with a reset procedure other than the one performed by DOS. No such program is provided by AST. Another useful addition is that the installation message displays the address where the buffer is allocated. The user interface is essentially unchanged from previous versions.

The documentation for RAMpage! lives up to the high standards set by previous AST hardware products. The hardware and software instructions are presented in two separate manuals. They manage to provide all pertinent information clearly and concisely without insulting the reader's intelligence. Perhaps the manuals are a little unclear for a user who has never installed a circuit board, but AST wisely assumes that its primary audience is somewhat more experienced.

To test the compatibility of RAMpage! and Above Board with one another, each of the utilities was run on the other manufacturer's board. All of them worked fine, including, surprisingly, REX on Above Board. Each EMM device driver, however, is specific to its own board and will not work with the other. This means that multiple expanded memory boards must come from the same manufacturer or at least be designed for the same device driver. Users who are installing one board now but who are planning to add more in the future will want to consider only those manufacturers that can be expected to remain in business until the additional boards are needed. Intel, which was a codeveloper of the base EMS specification, and AST, one of the leading board makers for the personal

TABLE 2: *Symphony Capacity Tests*

	CAPACITY RATIO	NO EMS NO. CELLS	WITH EMS NO. CELLS	NORMAL % FREE	EXPANDED % FREE
Integer constants	0.98	52,824	51,592	0	100
Real constants	2.9	17,608	51,592	0	80
10-character strings	3.9	13,205	51,592	0	70
50-character strings	12.9	3,201	41,125	0	0
Small formula[a]	10.0	5,155	51,592	0	1

[a]*A3 = (A1+A2)/2, A1 and A2 constant, A3 copied to the end of the column, then column A copied across the spreadsheet.*

The use of an expanded memory board for a spreadsheet application allows larger spreadsheets to be created. System size used in the capacity tests was 495KB available user memory (per CHKDSK) and 2MB expanded memory.

TABLE 3: *Symphony Execution Times*

	NO EMS	WITH EMS
Load 255KB file from hard disk	58	62
Copy 5,000 formulas	42	48
Recalculate 5,000 formulas	38	49

Execution time increases when the expanded memory board is used. The increase in memory is only slightly offset by a reduction in speed. Formulas used in these tests are the same as those used in table 2.

THE I/O ADDRESS SPACE

The 8088 microprocessor can address two distinct address spaces: 1MB of program/data space and 65,536 I/O ports. But just as IBM limited user memory to less than a megabyte, it also limited the usable I/O space to less than the processor's limit: 1,024 ports. Of these 1,024 ports, the first 256 are reserved for the system board, and the next 256 are not usable. That leaves 512 ports available in the expansion slots for use by adapter boards. Although reserving some memory space for bit-mapped video and ROM is reasonable (it may be argued, however, that IBM took more than necessary), the limitation on the number of ports seems arbitrary. Most adapter boards require a whole block of ports to support each peripheral device, so the lack of adequate I/O address space may begin to loom as large as lack of memory.

Several physical ports may be provided for each address in the 1K of I/O space, however. This possibility arises from the fact that the CPU is still capable of specifying all 64KB of possible I/O addresses; however, most adapter cards recognize only 1,024 of these. The reason is that the cards implement incomplete address decoding, as illustrated in the accompanying figure. The diagram is meant to be a conceptual representation of address decoding; it is not a schematic of the actual hardware components.

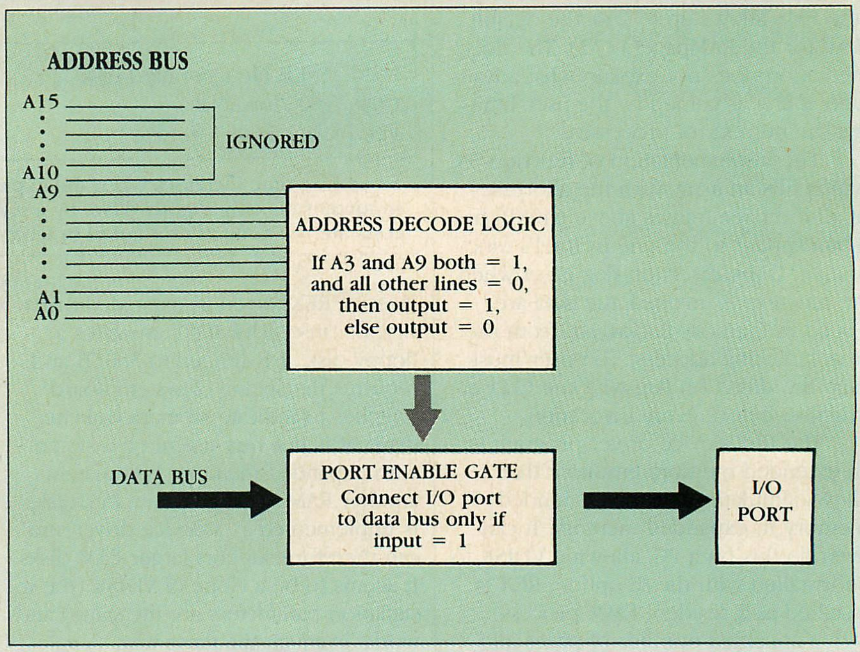
The address decoding circuitry samples only the lowest 10 of the 16 address lines. The port responds to any address with the proper bit pattern in those 10 bits regardless of the state of the high-order 6 bits. Thus, for the example given, the port responds to hex addresses 0208, 608, 808, A08, and so on for the 60 other addresses whose low-order 10 bits have the same pattern. In effect, incomplete address decoding makes each port take up 64 I/O addresses, reducing the available ports from 64K to 1K.

Because the address decoding circuitry is on the adapter board, not on the system board, a board may be designed to perform complete, or perhaps "less incomplete," decoding. The EMS boards decode two of the high-order 6 bits, thus providing four ports at each address in the 1KB address space. If the board's port address is set to 208, the four page registers are addressed at 0208, 4208, 8208, and C208.

This method does not magically expand the I/O address space back to 64KB. For example, ports cannot be addressed at F3F0 through F3F7, no matter how complete the decoding, because the block of eight diskette controller ports beginning at 03F0 responds to the same addresses. What this method does provide, however, is the potential for implementing as many as 64 ports for each address that is not already in use by a port that contains standard decoding circuitry. As more and more devices become available for the PC, complete decoding will be increasingly used in order to relieve congestion in the I/O space.

—TM

FIGURE: *Incomplete Address Decoding*



The EMS boards decode two of the high-order six bits that are not normally decoded in order to provide four ports at each of 1KB address space.

computer market, both qualify for inclusion in this category.

EXPANDED BENEFITS

Lotus Symphony 1.1 was used as a test of the benefits provided by expanded memory. It ran equally well on both Above Board and RAMpage!. In order to test the added capacity that is provided by expanded memory, an empty spreadsheet was successively filled with integer constants, real constants, short and long text strings, and a simple formula until the memory was exhausted. The tests were repeated both with and without the addition of expanded memory. The results of these capacity tests are given in table 2.

Notice that a "Memory full" condition can occur even when a significant amount of expanded memory is unfilled. This condition results because pointers to locations in expanded memory are kept in conventional memory; when that is filled, no more can be placed into expanded memory. Judging from the results that are shown in table 2, each expanded memory pointer takes up the same amount of space in conventional memory as does an integer. Therefore, integers are not placed into expanded memory; they would take up twice as much space.

The capacity of the spreadsheet is reached when the conventional memory is filled. If, however, expanded memory is filled first, additional cells are allocated in the remaining conventional memory. This situation occurs in the case of the long strings: in round numbers, expanded memory is filled with 34,000 cells, but about one-third of conventional memory is free at that point, and an additional 7,000 cells are placed there.

When Symphony starts up, it does not immediately allocate all of the free pages of expanded memory. Allocations are made only as needed, so that add-in applications (including programs executed through DOS.APP) also may use any expanded memory not currently being used by Symphony.

The advantages of expanded memory vary, depending on the makeup of a spreadsheet. Tests with some typical spreadsheets containing a mixture of labels and formulas of various lengths indicate that adding 2MB of expanded memory to 640KB of conventional memory expands the maximum number of cells by a factor of 3 to 4.

Although the EMS specification allows 8MB of expanded memory, the Lotus spreadsheets (Symphony and 1-2-3) support only 4MB. In practice, the typical spreadsheet can use no more than 2MB before filling up conventional memory on a system with 640KB of user memory. Installing more than one EMS board is useful when the spreadsheet holds a database rather than formulas or when using utilities that are coresident with the spreadsheet, such as RAM drives or print buffers.

The best news is that the expanded capacity is obtained at a tolerable cost in execution speed. Table 3 lists the times for loading a large file and for copying and recalculating short formulas (the same ones used for the capacity test), with and without expanded memory. In most cases, the speed penalty is less than 25 percent.

After all of the technical specifications are described and the tests run, the bottom line on expanded memory is, of course, how well it works. The verdict is overwhelmingly positive. The EMS can be immediately useful even to users who do not measure their spreadsheets by the acre. Running a system with 2MB of RAM disk and many resident utilities—with more than 400KB of DOS memory left over—is a joyful experience. The true potential of expanded memory, however, will be realized by systems software that can concurrently load, if not run, several applications. A variety of useful programs that take full advantage of the EMS currently are in various stages of development, and some are already available. Intel, for example, is currently bundling Above Board with Microsoft Windows, while AST is including Quarterdeck's DESKVIEW with RAMpage!. Both of these software packages are the latest versions that make full use of the capabilities that are available with the respective EMS specifications.

MEMORY EXPANSION BOARDS

In addition to Intel's Above Board and AST's RAMpage! reviewed here, several other boards are available that conform to the Lotus/Intel/Microsoft (LIM) and/or the AST/Quadram/Ashton-Tate (AQA) Expanded Memory Specification. Some of these boards are listed below. Their performances have not been evaluated by *PC Tech Journal*.

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JRAM-3: $269 with 0KB; $309 with 256KB; $589 with 2MB
JRAM-AT-3: $349 with 0KB
Supports LIM spec only
Tall Tree Systems
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Palo Alto, CA 94303
415/964-1980
CIRCLE 304 ON READER SERVICE CARD

Liberty: $395 with 64KB; $595 with 512KB; $895 with 1MB; $1,295 with 2MB
QuadMEG-AT: $445 with 128KB, $595 with 512KB, $1,295 with 2MB, $2,685 with 4MB
Supports both LIM and AQA specs
Quadram Corporation
4355 International Blvd.
Norcross, GA 30093
404/923-6666
CIRCLE 305 ON READER SERVICE CARD

Memory Companion/PC: $395 with 256KB; $699 with 2MB
Supports LIM spec only
STB Systems, Inc.
601 N. Glenville, Suite 125
Richardson, TX 75081
214/234-8750
CIRCLE 306 ON READER SERVICE CARD

TOP BOARD: $495 with 256KB; $695 with 512KB; $1,095 with 1MB; $1,895 with 2MB
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In comparing the Lotus/Intel/Microsoft and AST/Quadram/Ashton-Tate specifications, the latter appears to provide more flexibility by hedging the user's bets. It works with currently available applications written for the LIM standard and is ready for the applications that can make full use of all the enhancements—when and if those become widely available. As a matter of fact, Lotus, the arbiter of EMS compatibility, has certified RAMpage! as fully compatible with the EMS specification.

With Microsoft as one of the partners in the LIM specification, the possibility exists that future versions of the operating system will render the AST superset of functions unusable.

In comparing the two hardware offerings, the AST RAMpage! board is preferred not only because of its underlying design specifications, but also because the superior documentation and utilities make this a better package overall. This is not to say that Intel's Above Board is inherently flawed. Except for the print buffer utility, it is a good product in its own right.

Above Board AT: $795 with 512KB; $1,495 with 2MB; $2,690 with 4MB
Above Board PC: $495 with 256KB; $1,395 with 2MB
Intel Corporation
5200 N.E. Elam Young Parkway
Mail Stop TOC-03
Hillsboro, OR 97123
503/629-7369
CIRCLE 301 ON READER SERVICE CARD

RAMpage!: $595 with 256KB
RAMpage AT!: $745 with 512KB; $1,045 with 1MB; $1,495 with 2MB
AST Research, Inc.
2121 Alton Avenue
Irvine, CA 92714
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Ted Mirecki is a corporate planner who is responsible for developing decision support systems on a variety of hardware. He has a master's degree in computer science.

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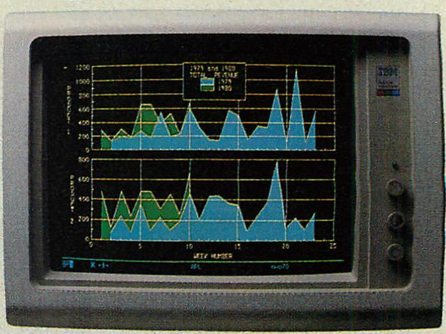

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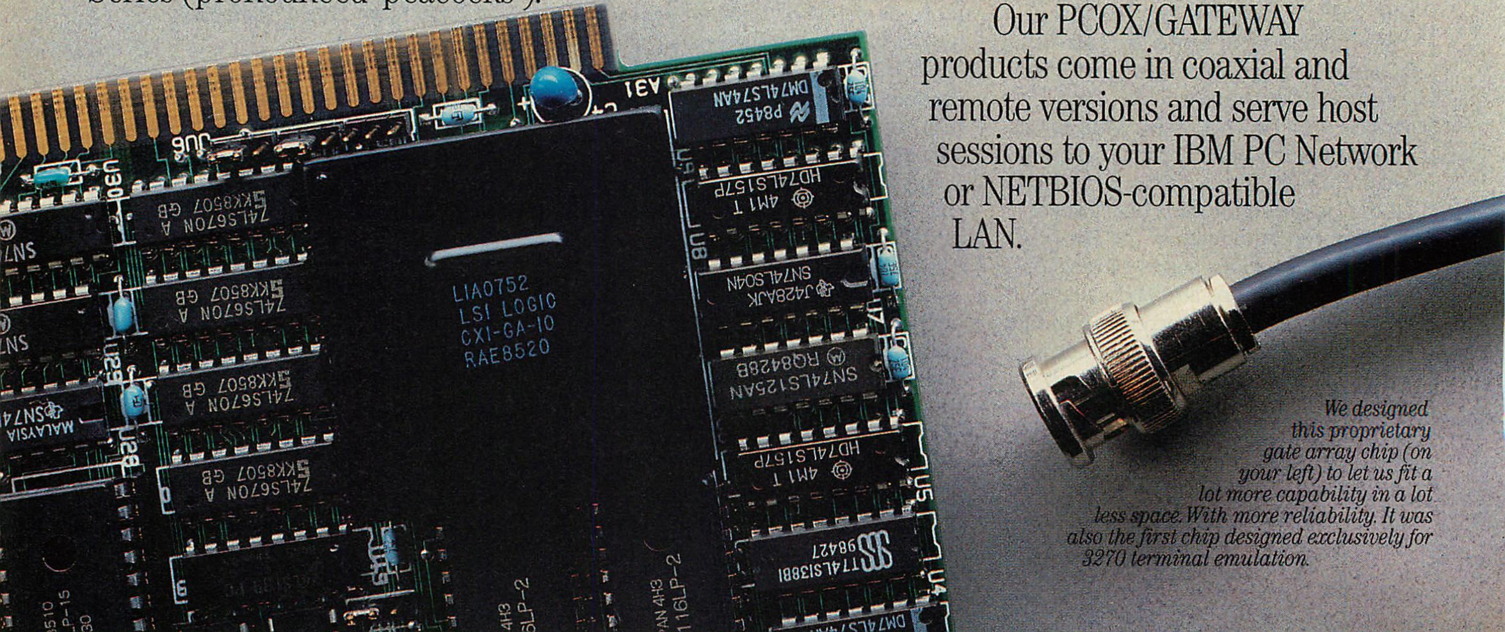

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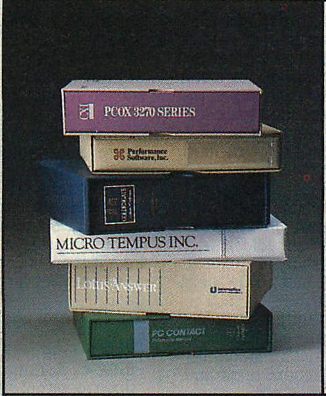

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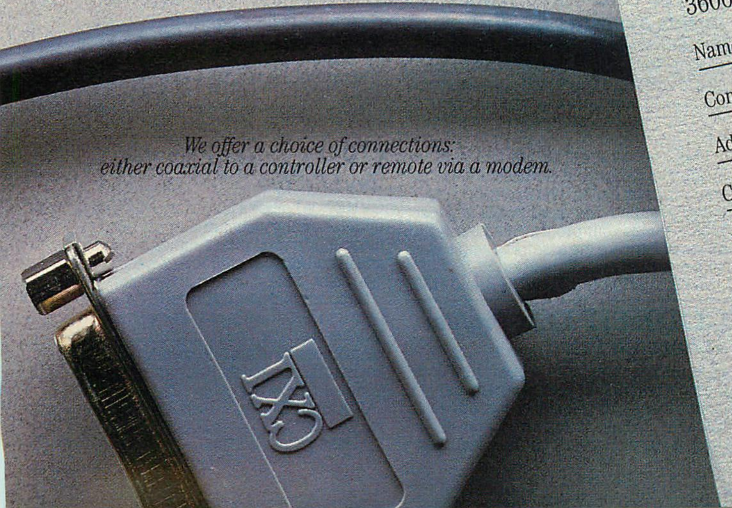

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Prospero Software's Pro Pascal™ was awarded a Class A certificate for its faithful implementation of the International Standard for Pascal (ISO 7185) conquering a suite of 740 tests, the only validated Pascal compiler for the PC and 8086 family of machines. Its UK creator has sold several thousand in a worldwide market where standards are a priority.

Turbo cannot compile programs utilizing standard Pascal features that Borland unaccountably sloughed off (e.g., get, put, page, function name passing). That's probably led to wordy equivalents in your programs at penalty of expanded size and run time. Bluntly, "there *is* a Pascal standard. [Borland] is definitely *not* standard Pascal" (Cortesi, *Dr. Dobb's Journal*, 7/85).

Pro Pascal corrects such deviance to make your work acceptable in any circles. Perhaps more enticing, it breaks free of Borland (and MT+™ and IBM®) 64k boundaries. Large memory model programs of 10,000+ lines and 1,000+ identifiers are now possible.

Pascal as defined is austere as an Alp, but Pro Pascal has sturdy outcroppings to hang onto: dynamic strings, random file record access, long integers, single and double precision floating point, an assembler level interface, and (again unlike Borland) separate compilation of program modules for later linking into large programs, so you can develop libraries of oft-used routines. Or disallow these extensions by the /s option whenever you require strict adherence to standard.

Prepare your source program using any text editor and Pro Pascal's three-pass compilation will convert it to Intel relocatable machine code for direct execution. Fast, tight code results which can use the 8087. The sieve runs faster than MS, MT+ or Borland, and produces a program *one third* the smallest of these.

Pro Pascal is a complete system. You get a librarian; a linker which scans libraries, accepts Assembler modules, and constructs overlays quite on its own (no contamination of source code); a cross-reference generator; a source and symbolic debugger offering multiple breakpoints and changable variables; and a runtime library which may be distributed with your work royalty free.

You certainly got your money's worth from Turbo, but Borland's bargain may now be getting very costly, so here's our deal:

Ask for:		List:	PC Brand:
P0100 <		$390	$ 345
P010X <	Borland Trade-In*		$ 299

*Upon receipt of original Borland disks

BRIEF

OUTSTANDING FOR ANY LANGUAGE

Is Anything But. A Whopper of an Editor

Dvorak in *Infoworld* said it for us: "the word is getting around...that Brief, The Programmer's Editor is simply the best text editor you can buy." With a name that belies its thoroughness, Brief™ has every feature you've ever contemplated for your editor-in-chief. *Here goes:*

Text, from keyboard or files, is housed in multiple buffers, and scrolled through one or more windows you open, close, resize. A text buffer may be called to different windows to view two areas at once. A change in one changes both. Text may be marked for printing, writing to files, movement to scrap buffers for cut and paste into other buffers, or deletion, with as many "undo" levels as you want.

To find and fix, Brief has text search abilities rivaling "grep", with wildcards for matching, indifference to intervening characters, acceptance of character ranges, even multiple choice of patterns and their replacements.

If you use Lattice, C86™, or Wizard, and have 320k, you can compile your C program without ever leaving Brief. It finds the lines with errors, and marches you through the text for repairs.

Parts of Brief were written with its own Lisp-like macro language. It has structure, 32-character variable names, conditional execution, loops, and you can actually read it! Nothing like the hieroglyphs we've seen elsewhere.

A macro compiler comes with your copy, and pre-written macros in source to give you the flavor. One even turns Brief into a word processor, with margin setting and wraparound. There's even a bulletin board and public domain disks with macros contributed by a mushrooming cult of macromaniacs. A disk full of contest-winning macros comes free with your purchase! (Needs 192k.)

Ask for: U0590	PC Brand:
List: $195	$CALL

CURSES *Unix Style Screen Management*

Curses is a Lattice® creation which manages the screen of the IBM PC in the same fashion as the curses utility of Unix. This C library has all the same functions of Unix curses with matching parameter lists. So your Unix program will be content when you move it to the PC, and programs created on the PC will be Unix compatible.

Curses is a library of eighty-four functions and macros which can keep any number of screen images in memory. A screen may be full or partial size, and any can be summoned to the physical screen at your programs's command.

The product supports color, and all four memory models. In keeping with the terminal orientation of Unix curses, the physical screen is re-painted (at high speed) only when your program calls a refresh function. Within a screen, Curses employs a vast function set to get characters, wrap lines, scroll, blank lines, highlight—virtually any tool needed to update the screen.

Ask for:	List:	PC Brand:
L0850	$125	$100
L0860 with Source	$250	$200

The TOOLSHED™ Trusted Favorites for a Well-Appointed Workbench

Interested but need to know more? Ask for literature about these products.

C-SPRITE *Lattice's Own Debugger*

This versatile companion to Lattice C™ displays function and variable names, data types, source code line numbers, and source itself. At any breakpoint disassemble object code and see source and assembler on screen.

Optionally offers machine addresses. Differentiates between C's data types to treat addresses as strings, long integers, etc., even pointers. At breakpoints set by symbols or addresses, C-Sprite™ will execute clusters of commands or commands that execute until a condition is met.

Debug through a COM port with a second terminal to leave a program's display screen undisturbed. Link with Plink86™, and C-Sprite can even tackle overlays.

Ask for: L2300	PC Brand:
List: $175	$145

PRO FORTRAN *With Source Debugger*

Prospero also offers a polished Fortran which satisfies completely ANSI X3.9-1966 (known as Fortran 66) and adds an abundance of Fortran 77 extensions (which may be blocked as a compile option). Its strict standards mean mainframe to micro compatibility.

Pro Fortran™ supports both small and large memory models, optionally uses the 8087, is equal to Microsoft in speed, but produces extraordinarily compact code—as little as 1/5 and an average of 1/2 the size of Microsoft's in tests we've seen! It comes with a linker, a librarian, and the same source debugger as Pascal above.

Ask for: F0100, List: $390, PC Brand: $345.

LMK *Unix-like "Make" Builds Systems Easily*

Working on a large program (in any language)? Tell Lattice's LMK™ what source files to compile using which options, which modules to assemble into what libraries, what libraries to search, what to link into the final product.

LMK keeps track of the last time every action was performed, and all the steps in your program system which depend on them. Over and over as you write and test, LMK rebuilds your program faultlessly, however intricate the assembly, and saves time doing only what's needed.

Ask for: L2100, List: $195, PC Brand: $159.

CODE SIFTER *Profiler at Bargain Price*

Several expensive programs will now find the sluggish spots in your program; our Code Sifter saves you plenty. It divides .COM or .EXE files into partitions on its own (or you can specify boundaries), then samples your program at precise intervals, counting how many times it finds the instruction pointer in each partition. Between each run Code Sifter can discard less active ranges and re-partition the hot spots, so that you zoom in literally byte tight! You'll see unmistakably where to optimize.

Ask for: N3100, List: $119, PC Brand: $99.

TEXT TOOLBOX *Tames Text Files*

Lattice has assembled a cluster of the most useful Unix text management tools into a single package. The Toolbox™ has:

"Grep": Rapid searching of any number of files to spot text patterns. Powerful expression syntax that goes far beyond your text editor's search command.

"Splat" substitutes new text for matches found using grep's syntax. "Files" can copy or erase files down paths to the point of eliminating full directory structures.

"Diff" compares text files line for line. "Ed" is similar to the well-known Unix editor.

Ask for: L2220, List: $120, PC Brand: $100.

CVUE *Customizable Text Editor*

CVUE™ is Lattice's text editor which has undelete, full path name support, and features important to programmers: recognition of non-display characters, pattern searching, indenting and undenting.

Supports text files as big as RAM. Compact and fast. Runs in only 64k with no tedious overlays. The real value: Even the binary version offers full customization of keyboard commands. Plus, opt for source code and make this editor truly your own.

Ask for: L2240, List: $75, PC Brand: $69. For Source Code as well, Ask for: L2245, List: $250, PC Brand: $195.

FIRSTIME *C Programmer for Hire. Real Cheap.*

Not interested in interpreters? Then explore the other fast lane to coding: language-specific editors. FirsTime™ is the strongest C editor we have seen, with many more commands and utilities.

FirsTime asks what program structure you want and sets up its skeleton for you: "main", or "function", or "if-else" or "while" or any component of C, with all semi-colons and curly braces tended to.

It puts placeholders into these structures to prompt you to enter code—the conditionals and counters which complete an "if", for example. FirsTime can even transform one type of structure into another, such as "for" into "while" or "while" into "do". It checks that variables you enter have been declared, and highlights errors. Material can be pulled into ten buffers for movement elsewhere. Your last delete is held in one of them for "undoing".

Movement through the screen highlights the successive logical blocks of your program so that structure is always apparent, and can hide lower level statements to show the outer framing of programs. Makes a big contribution to error-free code.

Ask for: E0460	PC Brand:
List: $295	$229

AND GETTING THEM TO YOU AT REDUCED PRICES, FAST. TRY US!

C-TREE

B-Tree File Manager, Source Code, No Royalties!

C-tree™ has been around since 1979. (It became Digital Research's Access Manager™). That means seasoned, sturdy code which hasn't cracked under the weight of prolonged and widespread use.

C-tree comes in C source code, revealing all you've ever wanted to know about how b-trees are written. Provided you bind it into your binary application, you can re-distribute C-tree without royalties.

C-tree's design splits nodes to allow any number of users to access an index file simultaneously even during updates. So multi-user configurations and adaptation to networks are possible. You must write record-locking routines, as they are compiler and operating system dependent, but the documentation shows how.

The latest version has new features: support of variable record length files; multiple key indexes in a single physical file.

Thanks to source code which does not deviate from the K&R standard, C-tree can travel. Tests in many environments prove that C-tree gives your application a ticket to anywhere.

C-tree permits any number of keys for a data file, supports duplicate keys, alphanumeric or numeric, etc., etc.—it's a comprehensive product with everything you'd expect. Intelligently designed, too, comprising both high level ISAM routines which minimize coding by handling all details of an activity; as well as decomposed step-by-step functions you can access directly. Either way C-tree maintains optimal index structures which will find a record amongst a million ten-byte keys in no more than five disk seeks.

Ask for: F0660 < — PC Brand: **$329**
List: **$395**

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ESSENTIAL C UTILITY LIBRARY — NEW!

300 Functions, 50¢ Each

Nothing pays you back quicker than function libraries, for our money the treasure of the C language.

Essential's huge package has 49 functions for screen movement, character manipulation, color display, and screen save and restore; 49 graphics functions to draw lines, shapes and color fill; 18 to rework strings in novel ways; 27 to set and obtain the default drive and file date/time stamps, plus make, access and remove directories and files; 22 for time and date validation, formatting, and elapsed time computation; 10 to allocate and free memory and execute other programs from within the current program; 24 to capture and control keyboard input; 18 to drive printers; others for communications, sound, and, and...

They are 95% in C, with those accessing DOS and BIOS (used by many of the C functions) in Assembler. Everything is supplied as libraries and as documented source, so even for C savants, there's much to be learned rummaging about. Demos show a sampling of what these procedures can be combined to do, and the manual clearly presents and describes all functions:

Lattice: U0300 / Mk Wms: < U0301 / C86: U0302 / DeSmet: U0303 — List: **$185** — PC Brand: **$150**

TOOLWORKS C COMPILER — NEW!

Benchmarks Embarrass Biggies at Giveaway Price!

Borland move over. If you are looking for minimum cost tools for learning C or for getting straightforward jobs done, we are happy to end your search.

Take a peek at the prices below, then look at the benchmarks. We have here a bargain C compiler with some very respectable clockings against not only low price compilers, but even against big-leaguers like Lattice. The timings will surprise you (will you look at floating point?).

Lattice it's not. Our Toolworks™ C doesn't have the full repertoire of features. But maybe you don't need them just yet. If the small memory model (64k for program and data each) will keep you busy for now, and you haven't yet found a reason for double precision math; if what you really need is to create C code and get it compiled, and you don't mind doing it for several hundred dollars less, then Toolworks C will be happy to generate remarkably fast and efficient compiled code for you.

To save the most, get the essential compiler—restricted to integer math values not exceeding ± 32k. Or order the Mathpak as well and receive a library capable of single precision floating point and long integers, as well as trigonometric, hyperbolic, logarithmic and powers.

Toolworks C has a configuration program to change the compiler's default option settings, and a runtime profiler to uncork bottlenecks. It can generate either object code or assembler compatible with Microsoft's MASM, and gives you source code of its complete standard library, which includes access to DOS and BIOS interrupts.

Our compiler doesn't care what generation of DOS you are creating for. Toolworks C supports register variables, can use the 8087 math chip, even has an exec( ) function which will branch to another program or a DOS transient and return.

It's simply packaged. Nothing fancy. But our evaluators tell us that it is easier to use than most compilers, and no bugs were found. Not surprising. This compiler is not new. It started life under CP/M™. Thousands of keybangers shaped the original to perfection's mold. We're so confident of reliability that if you are the first to document a bug, you can keep the compiler, and we'll refund your money.

30-DAY MONEY-BACK GUARANTEE

Even after using program disks, you may return any product in this space not coded "<" (by requirement of its developer) within 30 days for full refund of purchase price provided it is in our judgment in resalable condition.

	Prices:
TC001 Compiler & Runtime Library	**$49.95**
TM001 Mathpak for Floats & Longs	**$29.95**

BENCHMARK RESULTS Each test's best score indexed to 100.

	#1a	#1b	#2	#3	#4	#5	#6	#7	Compile Time	Compile Size
Toolworks	180	100	100	213	139	146/200	181/218	61k	162	135
Lattice		240	140	100	100	103/100	105/100	58k	205	121
DeSmet	670		113	107	100	100/130	100/113	60k	100	117
Ecosoft		160	115	116	110	101/130	105/143	fail	171	100

Test Key:
#1a: Floating point.
#1b: Same, using 8087 if capable.
#2: Function calls.
#3: Character counting.
#4: String copy using pointers.
#5: File copy using getc, putc; floppy/harddisk
#6: File creation, floppy/harddisk.
#7: Max. memory allocated using malloc( ).
Benchmark by DrasTech.

PRE-C

Thorough "Lint"-like Analysis Now on the PC

Unix users have always had "lint" to thoroughly clean programs before they disappear into a compiler.

Pre-C™ looms larger than "lint". It finds problems your compiler won't. Problems that a debugger will have trouble figuring out. Even problems which will cause trouble with other compilers.

Pre-C finds all the syntactical tripwires that will blow out a compiler and much subtler problems: code which will never be accessed, casts with suspect conversions, variables declared as external but never used, functions never called, machine-dependent expressions which inhibit portability, obsolete usage.

But the big service of "lint" is this: Compilers work with one module at a time. They know nothing of other modules which only meet up at link time. Pre-C looks at *all segments of your program at once* and reports to you any inconsistencies of inter-module references.

Pre-C uses the Unix System III compiler standard to guarantee maximum portability anywhere in the C world. There are then plentiful command line options to relax such rigor during early coding when work is incomplete.

Use purchased binary libraries? Profile them for Pre-C and it will thereafter insure that function calls from any C program are letter perfect. A miracle worker in speeding large system development. Needs 128k minimum; 192k recommended.

Ask for: P0590 — PC Brand: **$295**
List: **$395**

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dBC *Lattice Library Maintains dBASE Compatible Files With the Power and Speed of C*

dBC links C to dBASE. It creates and maintains files and their indexes which exactly replicate dBASE™ file design. So dBASE can read and update them. And the reverse. dBC™ can use any files created by dBASE. Now C and dBASE can operate on the same data bases interchangably.

That opens up the widespread culture of dBASE installations to exploitation by C programmers, and there are a lot of dBASE users out there. You can tap that market, avoid the resident dBASE language, and gain all the advantages of C with this single product.

dBC's functions parallel all dBASE's file handling commands, many decomposed to give closer control. The manual discusses each backed by demo source files on disk.

Use dBC for custom work for clients, or on its own. It's a complete ISAM file manager for C whether or not dBASE will be used in tandem, supports all four memory models, and can have sixteen index and data files open. Big discount to buyers of both dBASE II and III versions. Specify Lattice, Microsoft 3.x, or DeSmet compiler.

Versions:	List:	PC Brand:
L00II for dBASE II	$250	**$225**
LCCII With Source	$500	**$450**
L0III for dBASE III	$250	**$225**
LCIII With Source	$500	**$450**

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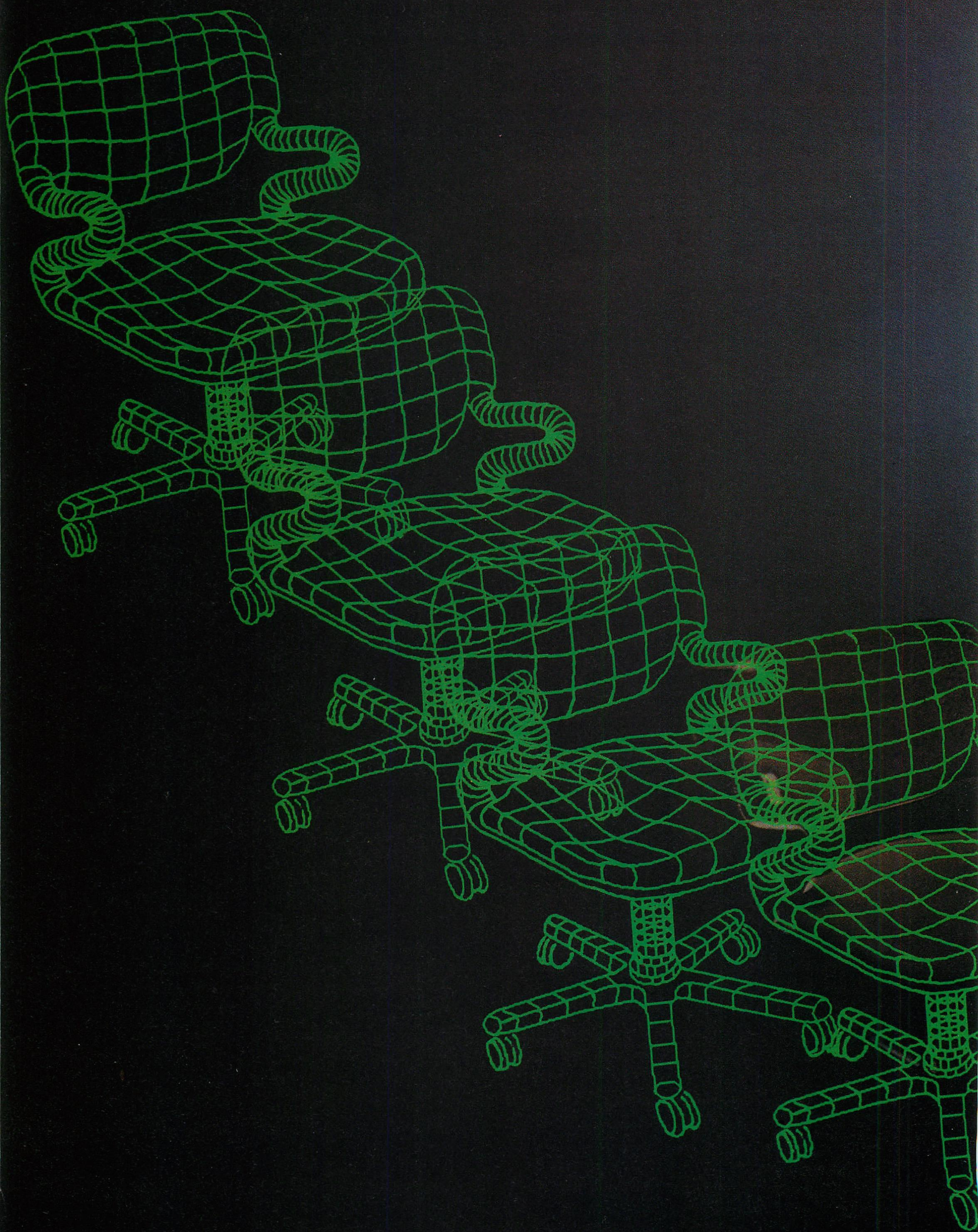


IMAGE • HERBERT WAGNER COMPUTER GRAPH

Three-Dimensional Modeling

When combined with a 2-D drafting system, MEGA CADD's Design Board Professional provides a complete CAD toolkit.

VICTOR E. WRIGHT

Microcomputers are not (yet) equal to the task of hosting a three-dimensional CAD (computer-aided drafting) system with all the features of a production drafting system—one that automates the tasks required to produce finished drawings, ready for the contractor, machinist, toolmaker, etc. Minicomputers and mainframes are needed to host these CADD (computer-aided drafting and design) systems. CADD is basically a CAD system with additional software that automates portions of the drafting and design process. The distinction between CAD and CADD is somewhat artificial, but a CADD system generally presents a user interface customized for a particular field of design, whereas a CAD system is a general drafting system with no discipline-specific features.

Microcomputers, however, do very well at hosting either two-dimensional production drafting systems or three-

dimensional modeling systems. MEGA CADD's Design Board Professional for the IBM PC family is a worthy example of the latter. The latest version, 2.04, was released in October 1985.

Design Board Professional provides the capability of creating 3-D models and displaying them in perspective views, with hidden lines shown or removed at the user's option. It is aimed at the designer—the person who creates and develops concepts—as opposed to the production draftsman. The program supports all the functions that a designer would reasonably expect, from interactive creation of 3-D models to storage on disk to plotted hard copy. MEGA CADD does not pretend that its product is a production drafting system, but instead has designed the system so that it can be used in conjunction with other production drafting packages.

DRAWING DATABASE

A CAD program is a database management system at heart. As each drawing entity is entered, it is recorded in a drawing database file (entities may be entered in a buffer in RAM and only periodically written to disk). A record is devoted to each entity, and the contents of the various fields in the record contain the data necessary to depict the entity graphically.

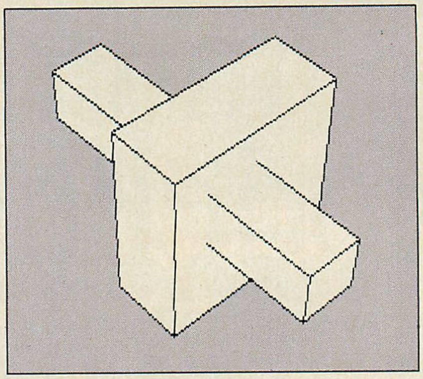
Each CAD system designer chooses a different format for the system's database, just as word processor designers and spreadsheet designers choose different storage formats. The differing formats account for the fact that one CAD program cannot read the drawing files created with another one, as well as for the different capabilities of one program in relation to another.

Design Board Professional maintains its entire drawing database in memory, as opposed to some CAD programs that maintain buffers and automatically write the information to disk when the buffers are full.

MEGA CADD does not describe its database structure in the manual; nor does it provide a data interchange format. However, a utility is available to translate drawing files to the interchange formats that are readable by other CAD programs.

Modeling programs, such as Design Board Professional, fall into two categories: wire frame modelers and solid modelers. Solid modelers know about solids and the surfaces that separate the solids from the surrounding space, and wire frame modelers know about the lines that form the edges of surfaces, but not about the surfaces themselves. A

FIGURE 1: *Line Removal*



Hidden line removal applied to intersecting objects created by a wire frame modeler produces a line disappearing into a surface.

solid model is opaque, whereas a wire frame model is transparent unless it has been processed to remove hidden lines. Most microcomputer programs that model 3-D objects are wire frame modelers, as is Design Board Professional.

A limitation of a wire frame modeler is that the program does not detect when one object is placed in the space occupied by another existing object. A wire frame modeler does not store a representation of a solid object or the surfaces that define the solid object. (Solid modelers known as Constructive Solid Geometry modelers and Boundary Representation modelers represent solid objects using those respective methods.) Therefore, the program cannot detect the intersection of two objects. This characteristic is revealed when two intersecting objects are displayed with hidden lines removed (see figure 1). When an edge of one object penetrates another object, the edge disappears, as it should, but no line appears where the planes of the two objects intersect.

HARDWARE REQUIREMENTS

Design Board Professional is fairly demanding of computing resources, as indicated by the following list of requirements: two floppy-disk drives or one floppy- and one hard-disk drive; 512KB of RAM; mouse or digitizer pointing device; 8087 numeric data processor; graphics card; DOS 2.0 or later. For hard-copy output, a graphics printer or pen plotter is required.

For this review Design Board Professional was tested primarily on an IBM PC with 640KB of RAM, an 8087, two floppy-disk drives, 15MB Winchester hard disk, Hitachi Tiger digitizer tablet, (also with a Mouse Systems mouse), the Houston Instrument DMP-42 plotter, and standard IBM Color Display and Roland DG MB-142. Several different graphics cards were tried.

The program also was run on a PC/AT during its evaluation. The power and speed of the AT make it the preferred machine, primarily because displays are generated more quickly, but the PC does a respectable job with the program, which is a large one written in FORTRAN.

The key to effective use of CAD is a good graphics display. A high-performance CAD system needs a high-performance display. Although detailed drawings may be created with a low-resolution display, the process is slower because the designer must change viewpoints more often.

High resolution generally is considered to begin at 640 pixels wide by 400 pixels high. (As a point of comparison, large CADD systems provide resolution of 1,024 by 1,024, some as high as 4,096 by 4,096, on screens ranging from 19 to 25 inches.) The standard IBM Color Graphics Adapter can achieve a resolution of 640 by 200—and that only in monochrome; for color, resolution is only 320 by 200. Design Board Professional supports several color/graphics adapters that offer higher resolution, however. Various configurations were tested for this review.

Tecmar's Graphics Master board provides a resolution of 640 by 400, operating in an interlaced mode, with a palette of 16 colors—although Design Board Professional makes use only of white, violet, and cyan. The Tecmar card should be used with a long-persistence monitor, because a standard monitor flickers when driven in the interlaced mode. Flickering was quite annoying when the Graphics Master was installed on a PC with the standard IBM Color Display attached, but barely noticeable on an AT with the Tecmar LP color monitor. The Tecmar monitor produced a slight smearing effect in noninterlaced displays.

The Tecmar Graphics Master also was tested driving monochrome monitors at a resolution of 720 by 704. The difference between the 720-by-704 and 720-by-352 displays is readily apparent, but not as dramatic as the difference between the 640-by-200 monochrome display of the IBM CGA and the 640-by-400 color display of the Tecmar card/IBM Color Display combination.

An AST Prevue card was tested with a Roland DG MB-142 monochrome display (white type on black background; the display can be reversed with the

push of a front panel button to produce black lines on a white background, which is very effective for CAD displays). To use Prevue, the Design Board program must be configured for the Hercules Graphics Card, which Prevue emulates. Both the Prevue and Hercules cards provide a resolution of 720 by 352, which is acceptable for CAD work.

One problem with the Prevue/MB-142 configuration was that the display could not be adjusted to show the border on all four sides of the Design Board Professional screens. When another monochrome monitor was substituted, the problem cleared up.

The IBM Enhanced Graphics Adapter and Hercules Graphics Card also were tested with Design Board Professional. The EGA display is impressive. The magenta highlights of the Tecmar Graphics Master are replaced with a bright red in the EGA, while the grid remains an unobtrusive cyan. The Hercules card produces a sharp monochrome white on black. These two cards were added to version 2.04, along with the Control Systems Artist I card and the Sigma Designs Color 400 card. Beta test documentation mentions that several cards supported under previous versions now are supported in additional configurations, but the production manual does not elaborate.

Design Board Professional also supports the Amdek MAI adapter, the Number Nine Resolution card, and the Conographics Cono-Color/Model 40. This last card has 256KB of RAM and drives an analog RGB monitor. Conographics recommends monitors by Electrohome and Aydin Controls, but Princeton Graphic Systems has announced its SR-12P analog RGB monitor, and the IBM Professional Graphics Adapter is an analog RGB monitor.

Because many users do not have high-resolution monitors and graphics boards but do have color displays, MEGA CADD designed its CAD system to produce a good display using the medium-resolution mode of the Color Graphics Adapter. The menus are not standard 40-by-25 mode characters, but a graphically produced font that resembles drafting text lettering.

INPUT DEVICES

Design Board Professional supports three types of input devices: keyboard, mouse, and digitizer tablet. Keyboard input is limited to numeric data for selected commands. Either a mouse or a digitizer tablet can be used as the interactive pointing device that controls the location of the screen cursor, a set of cross-hairs that extends across the screen vertically and horizontally.

The program supports both versions of the Microsoft Mouse, serial and bus, and the Mouse Systems mouse. Mice are easily installed, requiring only the installation of a device driver, which is furnished with the mouse, via the CONFIG.SYS file or a .COM file.

Several digitizer tablets are supported: Summagraphics MM1201, Summagraphics SummaSketch, Hitachi Tiger, and Kurta Series One. (Version 2.04 has added CalComp 2000 and 2100, Houston Instrument DT 114 HIPAD, Kurta Series 1, GTCO DP-5, and Summagraphics MM 961 and Bit Pad One to its list of supported digitizers). A digitizer tablet has no significant advantage over a mouse, because Design Board Professional does not provide a means of calibrating the tablet to digitize existing drawings. Installation of a digitizer tablet also is more complex than for a mouse.

The plotting program has been modified so the pen is lifted at the end of a stroke. If the plotter waits for data from the computer with the pen down, blots can occur.

In keeping with MEGA CADD's philosophy of running Design Board Professional in conjunction with a separate production drafting system, the two Summagraphics tablets can be configured to work with VersaCAD and AutoCAD as well as Design Board Professional. The manual advises that these tablets must be factory configured for packed binary format, 9600 baud, and odd parity. The Kurta Series One tablet can be configured by the user to work with Design Board Professional, AutoCAD, CADVANCE, and VersaCAD.

The Hitachi Tiger II tablet can be configured to work with Design Board Professional and only one of the three programs, AutoCAD, CADVANCE, and VersaCAD. The tablet has three switch blocks to set, and the three programs use different switch settings. Design Board Professional provides a device driver that works with any of the settings, but not all three. Another setting has been optimized for use with Design Board Professional only. Installing the Hitachi Tiger II requires a special cable, the wiring diagram of which is shown in the manual. Although the manual does not mention it, a Smart Cable can be used to connect the Hitachi Tiger II to the computer, thereby eliminating the need for a special cable.

HARD-COPY OUTPUT DEVICES

Design Board Professional supports a limited selection of dot-matrix graphics printers and pen plotters. Among graphics printers, only the Epson FX-100 printer and others that emulate it are supported. A plot produced on this printer is of lower resolution than that produced on a pen plotter, but printer plots are useful nonetheless. They can be plotted quickly and do not require refilling pens with ink. The scale can be specified for printer plots, and the plots are properly proportioned (round circles and square squares) even though screen displays are not always so.

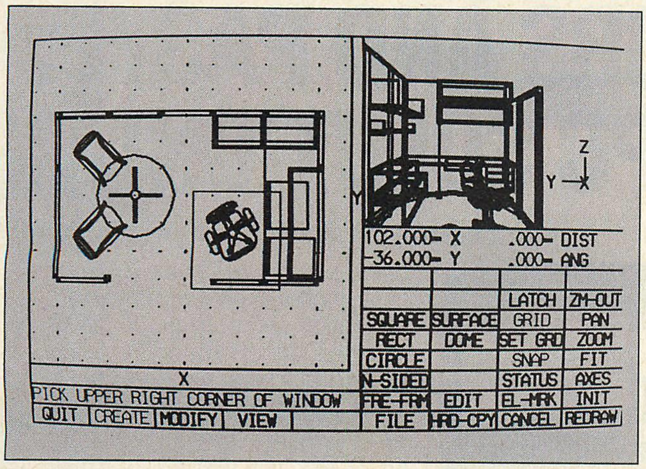
The selection of pen plotters is also limited: Hewlett-Packard models 7470, 7475, 7585, and 7586, and Houston Instrument models DMP-29, DMP-40, DMP-41/42, DMP-51/52, PC-595, and PC-695. The HP 758x series handles drawings up to E-size (47-by-36 inches), and the Houston Instrument DMP-41/42 and DMP-51/52 plotters handle drawings up to D-size (36-by-24 inches). Version 2.04 has added a few more plotters to the list supported by the previous version. Among them are the CalComp 1043 plotter, the Western Graphtec MP 1000, and Roland 880. The plotting program in version 2.04 also has been modified so that the pen is lifted at the end of a stroke. If the plotter were to wait for data from the computer with the pen down, blots could occur.

The manual provides all the information needed to make up the correct cable and configure a plotter. As with digitizer tablets, MEGA CADD has chosen cable configurations and communications protocols that are compatible with three other popular CAD systems—AutoCAD, CADVANCE, and VersaCAD. If a plotter is connected properly for operation with Design Board Professional, then it should work with any one of those three programs.

Installing Design Board Professional consists of configuring the hardware and creating working copies of the program to suit the hardware devices. The program is not copy protected, which greatly simplifies installation on a hard disk.

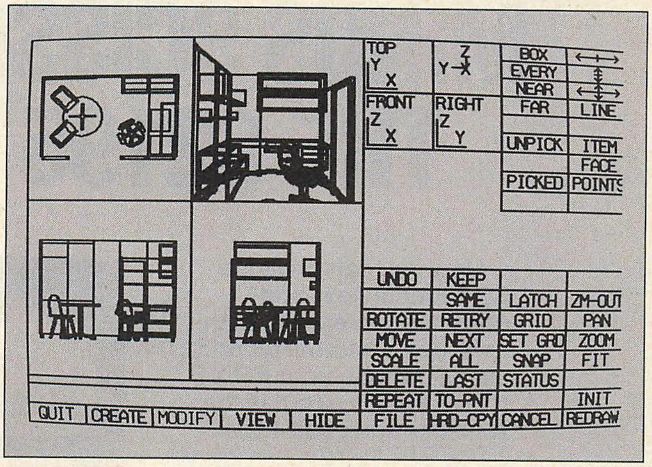
Once the hardware is connected and DIP switches positioned correctly,

PHOTO 1: *CREATE Screen*



Design elements are created in plan view and are developed automatically as a three-dimensional perspective model.

PHOTO 2: *MODIFY Screen*



Four different views can be displayed simultaneously. Changes in any one view will be shown in all four.

Photographs courtesy of MEGA CADD

the Design Board Professional program must be configured to recognize the hardware. This is done using a separate CONFIG.EXE program, which requests the type of graphics printer, graphics card, and plotter being used. It does not read previous configuration files for use as default values, so every question must be answered each time the program is reconfigured, even if only a single parameter is changed.

Device drivers must be installed prior to running Design Board Professional. If a driver is not installed, or if the wrong driver is installed, the program signs on and freezes up, waiting for word from an input device. The only way out is to reboot, because the program does not accept keyboard input for commands, even to exit.

The manual presents an example AUTOEXEC.BAT file and explains its contents for those who wish to automate the loading process, which consists of configuring the ports, installing operating system device drivers, and issuing the DBPRO command that actually invokes the program.

The Design Board Professional program operates in a loop. It waits for a command. When a command is entered, it requests the graphics data (or text) required to carry out the command. Then, it executes the command, updating the contents of the drawing database and the screen display. Finally, it returns to the top of the loop, and waits for another command.

Design Board Professional is an interactive program. It displays a screen cursor, which consists of a set of cross-hairs, at all times. The screen cursor can be positioned with a mouse or digitizer. In the case of a mouse, the screen cursor moves whenever the mouse is moved, but it does not reflect the absolute position of the mouse with respect to a certain frame of reference. With a digitizer, however, the position of the screen cursor does reflect the position of the digitizer cursor or stylus relative to the digitizer pad.

This is a menu-driven system. In three of the four screen display modes, a menu area is displayed. On the right-hand side of the screen is a menu block that varies with the mode. Across the bottom of the screen is a menu bar that lists those commands always available—QUIT, CREATE, MODIFY, VIEW, HIDE, FILE, HRD-CPY, CANCEL, and REDRAW.

Commands are executed by moving the screen cursor to the desired block and pressing the appropriate button. Some commands execute immediately; others require numeric data, in which case the program displays a numeric keypad on the screen, so that numbers can be entered in the same manner. The current version also accepts numeric data from the keyboard.

MODELING CONCEPTS

Design Board Professional provides the designer with a world of wire frame blocks, in which he or she can create models of complex objects. In the mode that is used to create models, these blocks are prisms, or extrusions of plane figures.

The names given to the basic prisms are the names of the cross-sections: *square*, *rectangle*, *N-sided*, *circle*, and *free-form*. Three-dimensional objects that are not blocks or extrusions of plane figures are called *dome* and *surface*. Complex models are created by combining these primitive 3-D objects.

A Cartesian coordinate system represents the models. The *X* and *Y* axes correspond to length and width of a plan view; the *Z* axis corresponds to the height above and below the *X-Y* plane.

Design Board Professional operates in four different modes, each of which displays the model in a different manner. Each mode provides separate facilities for manipulating the model.

The process of creating a model begins in the CREATE mode. The initial display provides a status area, a menu, and two windows (see photo 1). One window, occupying about two-thirds of the screen, is the creation space. It displays a plan view of a design space, 100 drawing units in each direction, centered on the origin of the drawing universe. The second window displays a perspective view of the objects drawn in the creation space.

As objects are defined in the creation space window, they are displayed in perspective in the perspective window. To ease the task of maintaining orientation, the perspective window also displays a diagram of the three axes, called the *perspective orientation diagram*. The creation space window includes axis labels, again to aid in maintaining orientation. A status area displays the current plan view coordinates of the screen cursor, the distance between successive data points, and a compass bearing when entering objects.

Version 2.04 allows configuration parameters, such as grid size and creation space dimensions, to be saved so the program starts with the proper configuration. The previous version always started with the same set-up.

Once the basic shapes have been entered from the CREATE mode, the

model can be edited in the MODIFY mode (see photo 2). Four views of the model are displayed—top, front, right, and perspective. New objects cannot be defined in the MODIFY mode, but the basic shapes defined in the CREATE mode can be rotated, scaled, moved, deleted, and duplicated. The basic shapes also can be stretched, compressed, and distorted to transform them into shapes that are not merely simple extrusions of plane figures.

The VIEW mode reverses the windows of the CREATE mode. The perspective view is displayed in the larger window, and a plan view is displayed in the smaller window. Again, new objects cannot be defined. Existing objects can be rotated, scaled, moved, and deleted, but not duplicated.

The fourth mode of Design Board Professional allows the user to view the model with hidden lines removed. The HIDE command displays a perspective view with hidden lines removed and without the clutter of screen menus.

CREATING BASIC OBJECTS

Creating an object, or drawing entity, requires the selection of a shape from the shapes menu—SQUARE, RECTangle, CIRCLE, N-SIDED, FREe-FoRM, SURFACE, and DOME—and the entry of the shape's dimensions along all three axes. The three dimensions—length, width, and height—can be entered in three different ways: interactively from the creation space window with the pointing device, from the keyboard, or a combination of the two.

With the exception of the SURFACE command, which creates a plane surface with four edges and vertices, and the DOME command, which creates a hollow spherical dome, the creation of an object begins with the complete specification of the plan view of the object. A cube or a prism of a square cross-section is selected with the SQUARE command, which prompts the user for two points to define the length of an edge and a third point to determine the side of the first edge on which the square will be drawn. When those three points have been entered, the program prompts the user for the elevations of the top and bottom surfaces. A prism of a rectangular cross-section can be created in a similar manner, except that the third point is used to determine the location of the side that is opposite the first edge, and therefore the second dimension, not just the orientation of the rectangle.

The CIRCLE, N-SIDED, and FRE-FRM commands all produce right cylinders of the specified cross-section. That is, the top and bottom surfaces are superimposed in plan view, and are perpendicular to the *Z*-axis.

The SURFACE command operates in a slightly different manner. A surface is defined by entering four *X-Y* coordinates in a circular pattern, but following each coordinate entry with the elevation of the corner. Surfaces need not be square in plan view, or in the true view, and they can be inclined with respect to any or all of the axes. When the surface has been defined, it is displayed as a network of 22 lines dividing the surface into 100 four-sided areas. The 10-by-10 net is the default setting; the MISC option of the STATUS command can be used to set the number of lines in each direction in the range of 2 to 17. The 2-line setting causes only the outline of a surface patch to be displayed, and the 17-line setting causes a surface patch to be displayed as a 16-by-16 net.

A dome is a portion of a sphere—a hemisphere or less—with a plane, circular base. The DOME command prompts first for the angle subtended by the base of the dome. An entry of 180 degrees, the largest entry possible, specifies a hemisphere. Then the program prompts for the center and radius of the base of the dome, and the orientation, allowing the creation of both convex and concave domes. The display of a 180-degree dome resembles a globe cut in half through the north and south poles, rather than at the equator, with the surface defined by the net of latitude and longitude lines (parallels and meridians). A dome of less than 180 degrees is defined by the same number of lines, but distorted in order to produce the flatter shape.

The coordinate display is limited to five digits, providing a universe that stretches from -99,999 to 99,999 drawing units in each of three directions—adequate for any design task.

Version 2.04 has added a WALL command to the shapes menu that allows buildings to be drawn more easily. With the earlier version, walls had to be entered as FRE-FRM shapes, which required entering inside and outside faces separately—beginning at a corner and working around the outside and inside faces to return to the starting point. The WALL command allows the designer to specify a beginning point, an end point, and intermediate vertices (or corners), followed by the elevation of the top and bottom of the wall. The beginning point is displayed as a target; if a vertex is entered within the target, the program closes the figure and ends the command. If a closed wall is not desired, the user can end the sequence with the END command.

The initial creation space display of Design Board Professional is 100 units square—hardly large enough to model skyscrapers—however, the space available for design is much larger. The STATUS-UNITS command allows specification of English (feet and inches) or metric (meters) units, with fractional units displayed either in fractions ranging from 1/64 inch to 1/2 inch or in decimal fractions.

The display also may be varied to show a larger or smaller portion of the drawing universe. ZOOM displays a smaller volume, ZM-OUT displays a larger volume, and PAN changes the location of the volume in the universe without changing the size. Although the manual does not mention the size of the drawing units, a little experimentation with the ZM-OUT command reveals that the coordinate display is limited to five digits, providing a universe that stretches from -99,999 to 99,999 drawing units in each of three directions—adequate for any design task.

GRID, SET GRD, SNAP, LATCH, and EL-MRK fall into the class of drawing aids, or alignment commands. GRID toggles the grid on and off. The grid is a network of dotted lines that facilitates maintaining orientation in the drawing. The SNAP command is also a toggle. When SNAP is on, data points can be selected only at the interval to which the grid has been set with the SET GRD command. Both the GRID and SNAP command blocks are displayed in reverse video when the modes are on.

The grid has two settings: the working grid size, which determines the snap interval, and the visible grid multiplier, which determines the size of the grid displayed. One of Design Board Professional's weak points is its handling of the grid. By zooming out without changing the grid size, or turning off the grid, the designer may end up with a display that is all grid dots—after an extremely long delay. Fortu-

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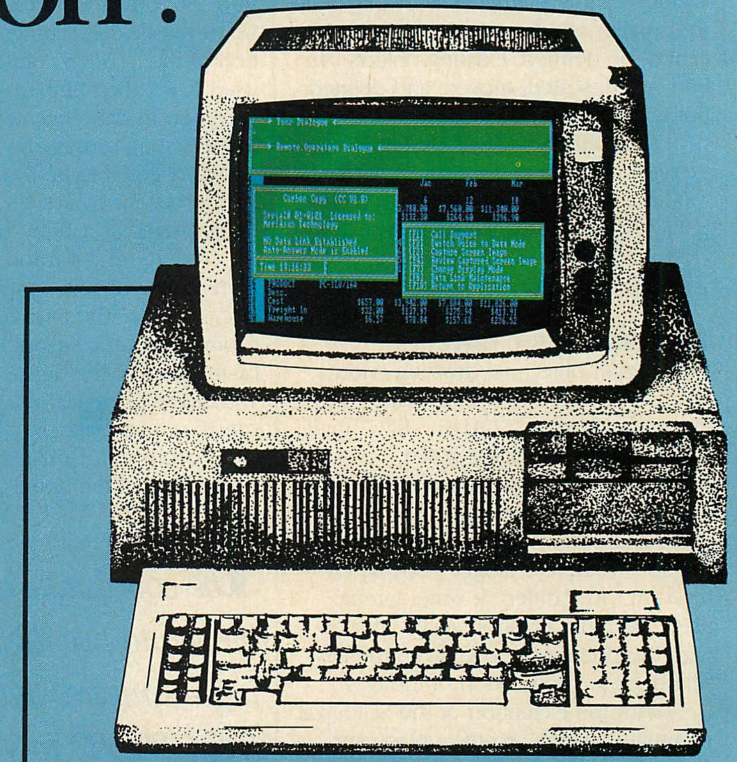

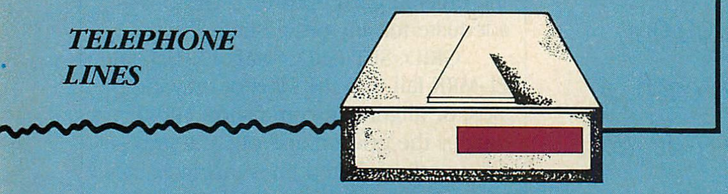

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nately, Ctrl-Break or Ctrl-X terminates a zoom and redraw sequence. Even at reasonable grid settings, the program takes as long to redraw the grid as it does to redraw a simple model, so working with the grid turned off most of the time is advisable.

The LATCH and EL-MRK commands define relations between objects. Specifically, these two commands allow two objects to share a common point, line, or face. LATCH links objects along the *X* and *Y* axes, and EL-MRK links objects along the *Z* axis. LATCH is particularly useful in modeling large, complex curved surfaces. In the latch mode, the vertices of new surfaces snap to the vertices of existing surfaces in elevation if the two vertices are within the current snap resolution. When a vertex of one surface is latched to a vertex of another, the elevation is not specified. Surfaces can be latched only at the vertices. A vertex of a surface cannot be latched to the midpoint of an edge—the elevation must be specified. (Surfaces will latch to the control points of other surfaces.)

As noted above, objects are created by defining both a plan view and top and bottom elevations. That would be a limitation without the AXES command, which allows the user to specify which plane is displayed in plan view. Stated more correctly, objects can be defined either from a plan view or from elevation, or side, views.

The EDIT command replaces the shapes menu with an editing menu. This menu provides five basic commands—ROTATE, MOVE, SCALE, REPEAT, and DELETE—and various qualifiers—LAST, SAME, NEXT, KEEP, and RETRY. In addition, a SHAPES selection returns the user to the shapes menu. Switching between the shapes and editing menus does not disturb the display and alignment menu selections. The EDIT and SHAPES boxes are in the same location on the screen.

The ROTATE command deserves special mention. Although objects generally must be created so that they are aligned with the three axes, they can be arbitrarily rotated with respect to any or all of the axes.

One last command on the CREATE screen is the STATUS command, which displays a menu of three choices—MISC, PERSP, and CREATION. These commands display and allow specification of various system parameters, such as the dimensions of the creation space, the location of the window in the creation space, and whether or not distances between data points are displayed along with absolute coordinates.

The STATUS-MISC selection includes CURSOR, which is a toggle that switches the cursor from full-screen cross-hairs to a small tracking cross. The smaller cursor seems to flicker less than the larger one. (Incidentally, the full-screen cursor on the EGA configuration does not actually stretch the complete dimensions of the screen.)

One selection in the CREATION submenu that deserves mention is a command that allows the specification of two *clipping planes*. If the *X-Y* plane is displayed in plan view, the command is ZCLIP; if the *X-Z* plane is displayed, the command is YCLIP; and if the *Z-Y* plane is displayed, it is XCLIP. The clipping planes ease the task of working with a model that has many objects at different elevations, which overlap in plan view. The clipping planes define a slice of the model for display. The top of the slice is defined by the near clipping plane, and the bottom is defined by the far clipping plane.

Several of the editing commands are more powerful in the MODIFY mode than in any of the other modes.

MODIFYING MODELS

The commands of the CREATE mode permit the construction of detailed models from standard shapes. Unfortunately, these standard shapes do not adequately fit the needs of most of the designers who would want to use Design Board Professional. The MODIFY mode provides the commands that customize the standard shapes into shapes of arbitrary complexity. Right circular cylinders can be transformed into cones, square cylinders into pyramids. A prism created with the top and bottom surfaces can be modified so that either the top or bottom, or both, are inclined with respect to the original plane or so that the axis is inclined.

The MODIFY screen provides four views of the model—top, front, right side, and perspective (see photo 2). Almost half the screen is devoted to menus. The upper half of the menu area contains a key diagram, or axis icon area, and the modify menu. In the lower half of the menu area is the edit menu, which provides the five editing commands and the same qualifiers as does the edit menu in the CREATE mode. However, the MODIFY mode has an additional command, TO-PNT, that can be used to collapse a group of points, perhaps an entire fact, to a single point to produce pyramids, cones, and other arbitrary shapes.

Several of the editing commands are more powerful than they are in the other modes. The SCALE ALL command does not scale the model as it is defined in the drawing database, but affects only the perspective view. If the designer defines the model in the CREATE mode, invokes SCALE ALL in the MODIFY mode, returns to the CREATE mode, and then returns to the MODIFY mode once more, the model will be the same in the top, front, and right side views, but the perspective view will be changed.

All the editing commands require selecting the objects to which the command applies. This is done by placing the screen cursor on one of the object's vertices and clicking the pointer button or by drawing a box around the item. When an item has been selected, it is highlighted, and the KEEP qualifier executes the command. Most commands can apply to several objects. Selecting several objects that are superimposed in one or more views can be frustrating, but practice does improve performance.

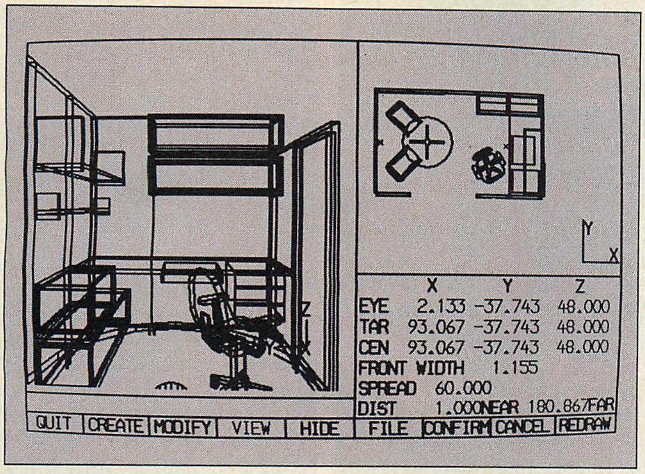
The MODIFY mode provides the facilities to create curved surfaces of arbitrary complexity. As noted above, the CREATE mode allows the creation of plane surfaces, and it displays those surfaces as 10-by-10 grids. The program actually defines a surface as a set of 16 control points that divide the surface into nine areas. In the MODIFY mode, the program displays only the 16 control points and a grid of 16 lines.

The control points control the shape of the surface, according to the Bezier Theory of Surfaces. If the control points are arranged in a plane, the resulting surface is a plane. Surfaces are planes when originally created, with the exception of domes.

Displacing one or more control points from the original plane distorts the plane into a curved surface. The surface remains coincident with the 12 points on the periphery of the surface, but all points can be moved from the original plane, allowing surfaces to curve in one or two directions.

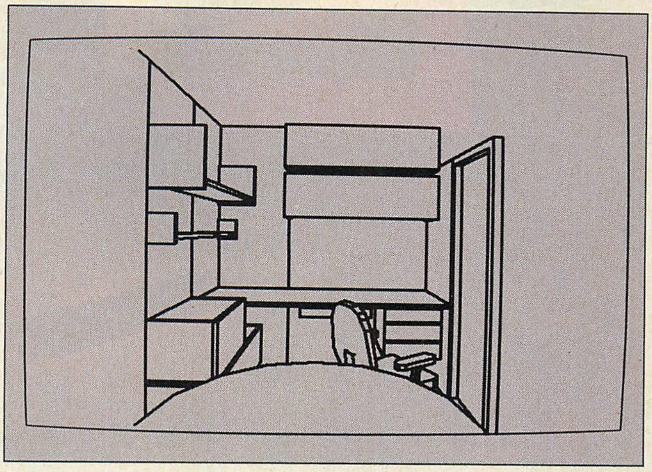
A net of 16 control points is hardly sufficient to create surfaces of arbitrary complexity, but many surface patches can be LATCHed together to create large surfaces with many control points. A complex surface can be modeled with

PHOTO 3: *VIEW Screen*



The VIEW screen shows the perspective view as the main view. It can be rotated by alterations made to either the eye, the target, or the height variables.

PHOTO 4: *Perspective View*



The perspective view of the three-dimensional model can be processed to remove hidden lines by the HIDE command. The display does not have any menu areas.

Photographs courtesy of MEGA CADD

many small surface patches, whereas a simple surface can be modeled with a few large surface patches.

The surface patch does not appear contoured in the MODIFY screen, but rather appears as a faceted surface through the control points. In both the VIEW mode and the perspective view of the CREATE screen, however, the surface does appear contoured.

The number of lines to be shown in the contoured display can be set by selecting MISC from the STATUS menu. The default value of 11 lines in each direction can be changed to 2-17 lines.

The MODIFY screen includes a PROJECT command that eases the task of creating shapes with inclined surfaces. The basic shape menu still creates right cylinders with both the top and bottom surfaces parallel to the *X-Y* plane (or *X-Z* or *Y-Z*). Modifying these surfaces under the previous version meant moving edges or points until the surface was in the desired plane. PROJECT allows specification of the surface to be projected and of the plane onto which it is to be projected, after which the cylinder is extended or truncated so that the specified surface is coincident with the projection plane.

The ruler display is available in the MODIFY mode, as well as in the CREATE mode. This is an important enhancement for the latest release, because it greatly eases the task of editing in this screen. Earlier versions required an iterative procedure.

VIEWING MODELS

The VIEW mode provides the ability to see the three-dimensional model in perspective, and at a larger size than that of the perspective view of the CREATE screen. The VIEW mode shows the perspective view in the large window on the left half of the screen and the plan view in the smaller window over the menu area (see photo 3). This is the opposite of the CREATE screen.

The menu changes when the VIEW screen is displayed. The menu bar displays an additional command, HIDE, and the shapes menu is replaced with the editing menu.

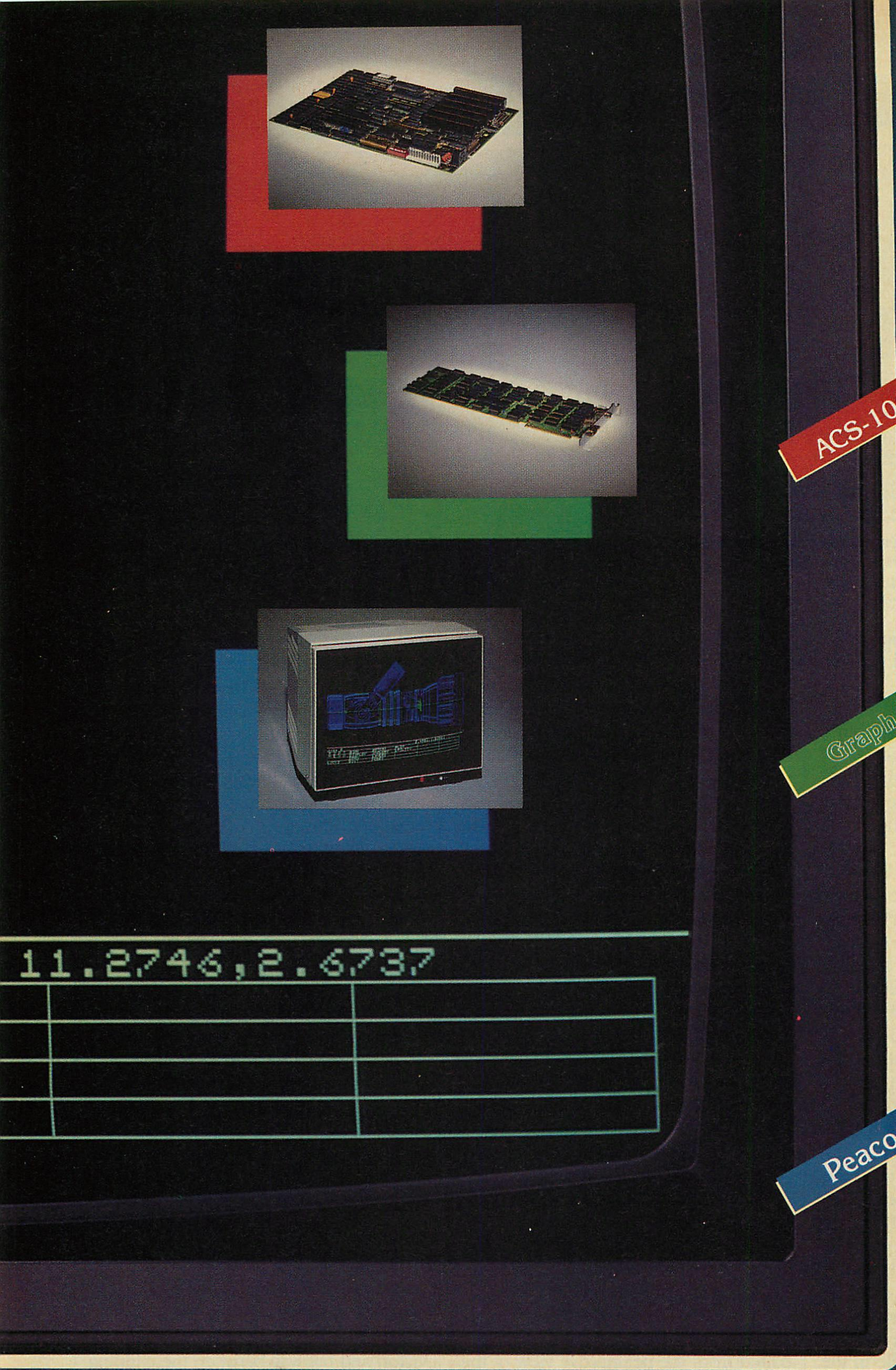
The display controls—ZOOM, ZM-OUT, FIT, and PAN—apply to both windows; the editing commands apply only in the perspective window. While in the VIEW mode, the perspective view can be edited—individual objects, or the entire model, can be rotated, moved, scaled, and deleted. Editing the entire perspective—for example, rotating the entire model—does not affect the drawing database, but only the perspective view of it. The model remains in the orientation in which it was created, relative to the axes.

The EL-MRK command, which displays the top and bottom elevations of shapes, is available in both the VIEW and the CREATE screens. This command is useful for selecting an object to be edited from the perspective view of the VIEW screen, because it highlights the object. The object can be selected from either the large perspective view or the smaller plan view.

All parts of the current model are continuously displayed in perspective. Each time an object is added, deleted, or modified, the perspective view is updated. A perspective view is determined by several parameters. The first is the location of the viewer in relation to the model, often called the *viewpoint*, but referred to simply as the *eye* by Design Board Professional. The next parameter is the direction in which the viewer looks in relation to the model, called the *target*. The viewer is at location eye, and looks toward location target.

The eye-target line is the axis of a portion of the universe or creation space called the *cone of vision*, which encloses the model or portion of the model that is visible. Actually, the cone of vision is a four-sided pyramid, because the view of the model is rectangular. The apex is at the eye, and the target is inside the pyramid, halfway between two clipping planes. The viewer sees only the objects or parts of objects inside the cone of vision and between the clipping planes. Objects in front of the near clipping plane and behind the far clipping plane are not displayed. The cone of vision cannot include an angle that is larger than 180 degrees, meaning that both the near and far clipping planes must be in front of the eye location.

Another point also affects the perspective view: the *center*. This point initially coincides with the target at the location on the axis of the cone of vision and halfway between the clipping planes. However, the target always remains directly in front of the eye, and the center always remains on the axis of the cone of vision, which can be skewed by certain commands. For example, the PAN command moves the eye and the target in a direction parallel to the clipping planes, but leaves the center unaffected. Thus, the perspective of a model is not changed by PAN. It does not produce the effect of moving



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in a three-dimensional world—that is, a constant change in perspective view. Instead, the effect is that of walking past a perspective drawing, or projection of a 3-D drawing on a plane.

Like PAN, the commands ZOOM and ZM-OUT also leave the locations of eye, target, and center unmoved in relation to the model. They enlarge or reduce only the portion of the model that is displayed in the window. Again, the effect is that of moving toward or away from a perspective drawing, rather than of moving through a landscape along the line of sight.

In the VIEW mode, the ROTATE, MOVE, SCALE, and DELETE commands affect the perspective view of the model in that they change the relationships between the objects in the model. The eye, target, and center points remain fixed in relation to the space in which the model was created. Rotating, moving, scaling, and deleting objects requires that the perspective view be updated to reflect the changes.

The perspective view may be altered without changing the model. SETVIEW allows the specification of the eye and target points in all three dimensions. When both points have been located, a new perspective view is generated, with the target and center points again coincident.

The PERSP option of the STATUS command provides another mechanism to refine perspective views. Invoking PERSP first displays the key statistics about the perspective view. Specifically, the program displays the coordinates of the eye, target, and center points in three dimensions, the distance of the near and far clipping planes from the eye, the front width, and the spread.

Of the values displayed, the eye, front width, near distance, and far distance can be changed directly by choosing the name of the value and typing in new values or choosing the new values from the calculator keyboard displayed on the screen. The remaining values cannot be set directly; they are calculated from the values that can be set.

The SETVIEW and PERSP commands provide similar, though not identical, facilities. SETVIEW allows the location of the eye and target points to be set directly. The ZOOM and PAN commands can be used in conjunction with SETVIEW in order to vary the spread of the cone of vision. The PERSP command provides control of the eye point, clipping planes, and the cone of vision, but not of the target point. The SETVIEW command is available to the user only in the VIEW mode, but the PERSP command can be used in both the CREATE and VIEW modes.

All these view management facilities taken together provide a means of moving around and through the model for a limitless number of presentations. The value of the continuous perspective generation facility should be obvious to any designer who relies on perspective views to portray design concepts.

While Design Board Professional is not a production drafting system, it does provide all the facilities necessary for the preparation of schematic plans. As the designer develops the schematic plan, the perspective view is updated continuously. Therefore, the designer has the perspective view available as a feedback device at all times.

After the model is complete, the perspective generation facility allows the designer to select the view that best portrays the design. This option is a vast improvement over the selection of standard views by rote or producing several views manually and then selecting the one that seems best for development into a full color rendering. The HIDE command processes the drawing and removes the hidden lines. The display does not have any menus visible at this point allowing a full perspective view of the drawing (see photo 4).

The value of the continuous perspective generation facility should be obvious to any designer who relies on perspective views to best portray design concepts.

PLOTTING DRAWINGS

Plotting is initiated with the DRAW command from the main menu bar. DRAW displays a menu that includes the selections, PLOT, PRINT, and SCREEN. If the program has been configured for both a plotter and printer, it asks whether to print or plot the drawing. After that selection is entered, the program asks whether the drawing is to be scaled if a plan view is being plotted. If so, it suggests a scale and requests confirmation before the plotting/printing operation begins. If the suggested scale is not accepted, the numeric keypad is displayed, and a scale factor is requested. It must be specified as the fraction of an inch that represents a foot.

If a perspective view is being plotted, the program does not request a scale factor. For a printer plot, it fits the view to an 8½-by-11-inch sheet of paper; for a pen plotter, it requests the media size from a list of choices.

The last question asked is whether to erase hidden lines before plotting. Hidden line erasure takes longer than the plot itself, but is often essential. As the hidden lines are removed, the drawing is displayed on the screen. When the screen display is complete, plotting begins. Version 2.04 includes a revised hidden line removal algorithm that speeds the process slightly.

The SCREEN selection in the DRAW menu displays the current main display, with the view of the model in the left window without the clutter of menus and auxiliary views. If the program is properly configured (to be used in conjunction with the Design Board Illustrator), these views can be saved as picture files by typing Ctrl-G.

File handling is accomplished with the FILE command on the main menu bar. Invoking FILE displays a file menu that includes the commands RECALL, SAVE, MERGE, APPEND, CONTINUE, LIST, MORE, ENTER, and CLEAR, and a block for file name entry, NAM=. The commands must be selected with the pointing device, but file names can be typed in from the keyboard, or called up with the LIST command and selected with the pointing device.

Files are not saved automatically at the end of a session, nor are they written to disk periodically during a session. The user has to save the model, and saving it does not clear the model from the machine's memory. Both the SAVE and RECALL commands automatically append the file extension .DB3, and both commands can be used with LIST in order to produce a list of existing files on the screen.

MERGE and APPEND allow models stored on disk to be inserted into the current model. The MERGE command places the model in the merged file at the coordinates at which it was created. APPEND allows the location of the inserted model to be specified. Therefore, MERGE permits segmentation of a model in order to speed response, and APPEND allows the use of standard components, or symbol libraries, so that these standard components can be inserted arbitrarily. The symbol library capability is a feature that is essential to any system claiming to approach the level of a CADD system.

ADVANCED MODELING

The Design Board Professional manual includes a section entitled "Advanced Modeling," which illustrates several techniques for creating complex models and sophisticated presentations. The first technique presented is one for creating four-view plots— the standard three-view orthographic drawing plus perspective view—on the same sheet of paper. The technique relies on the MODIFY mode to position the object in each of the views in a different quadrant of its respective window. After the views are set up, each view can be plotted in turn, without removing the media from the plotter.

One of Design Board Professional's drawbacks is that it does not use the disk as a virtual storage device; it writes to disk only when the SAVE command is issued. Thus, the size of the model that can reside in memory at any given time is limited. (Some production drafting systems update the disk file periodically, so the absolute limit on drawing file size is imposed by the operating system limits on file size (the deterioration in response time redrawing large models may impose a lower, practical limit on drawing size.)

However, several models can be plotted on the same sheet of media, to produce a hard-copy model that is larger than the largest model that can be held in memory. The technique is essentially the same as that used to create four-view plots—running several plots in succession without removing the media from the plotter. The individual models used to create the composite model must be constructed in the proper locations in the creation space, all using the same coordinate system. The individual models must be set up so that the perspective view parameters, such as eye and target, are identical. This technique is equally suited for large plans and perspectives. The manual presents an example in which a composite city planning model is plotted from individual models, each consisting of a single block.

The "Advanced Modeling" section of the manual also presents a technique for creating a hollow object—not a trivial matter in a wire frame modeler, because it does not represent solid objects or their surfaces, only the lines defined by the intersection of surfaces.

A feature that large system CADD manufacturers never fail to mention when trying to sell a system is walk-through viewing. In fact, most of them extend the concept to "fly-around-and-in-and-through" viewing. Design Board Professional provides the same capability with the SETVIEW command. The manual illustrates a walk-through tour of the PROHOUSE model, included on the disk of models provided with the system. Creating a walk-through tour is somewhat time-consuming with Design Board—just as it is on even the largest and most powerful systems.

Another advanced modeling technique covered in the manual is the use of clipping planes as a means to simplify the task of detailing models, especially those that require detailing at various elevations—such as a multistory building. The clipping plane feature allows the designer to work in a slice of the model, suppressing the display of lines above and below the slice. The program also limits the selection of items for modification. Only visible features can be selected.

One of Design Board Professional's drawbacks is that it does not use the disk as a virtual storage device; it writes to disk only when the SAVE command is issued.

Another example of an advanced modeling technique is the creation of a complex curved model—a pitcher. This stresses the importance of the Bezier technique and the LATCH command.

USE WITH OTHER PROGRAMS

Design Board Professional is primarily a conceptual modeling tool. It lacks many features of production drafting programs—features such as automatic dimensioning, automatic cross-hatching, polylines, layers, and creation of blocks. MEGA CADD does not pretend that this product should be the only CAD tool in the designer's toolkit. Instead, the company suggests that it should be used in conjunction with a production drafting program. MEGA CADD has gone to some length to ensure that its hardware configurations are common to three supported production drafting programs: AutoCAD (versions 1.4 and 2.x), CADVANCE, and VersaCAD.

MEGA CADD also provides a translator program, called Design Board Link, that can extract two-dimensional views from Design Board Professional models and produce drawing exchange files for use with the three 2-D programs that were just mentioned.

DBLINK is not an interactive program. It requests the type of exchange file it is to create, the source file name (a Design Board Professional file with the extension .DB3), and the type of information to extract.

The program allows the extraction of orthographic, isometric, or saved views. If an orthographic view is selected, an additional six choices are available—front, back, left, right, top, and bottom. The isometric selection produces eight additional choices, depending upon the views to be displayed on the faces of the isometric cube.

The saved view selection provides only two choices: perspective or axonometric. Axonometric views are similar to isometric views in that lines and planes do not converge to vanishing points. However, an isometric view is constructed at standard angles (the eye-target line in a true isometric view would make an angle of 35 degrees 16 minutes with the *X-Y* plane and a 45-degree angle with both the *X* and *Y* axes), whereas the viewpoint of an axonometric view can be specified. Both perspective and axonometric views extracted from Design Board Professional files are dependent upon the perspective view saved in the drawing file. All views can be transferred with hidden lines displayed or removed.

DBLINK was tested with AutoCAD 2.1, transferring the several views of the PROHOUSE model from Design Board Professional to AutoCAD. The process went smoothly, with only one surprise. The resulting AutoCAD drawing had an origin at 0,0 in one case, and in the third quadrant (both coordinates negative) in another. This is not a serious problem, but most users would reposition the entire model to the first quadrant (both coordinates positive).

DBLINK is a one-way program. It extracts information from Design Board files and produces drawing files for 2-D programs, but it does not process 2-D CAD files to produce Design Board files. Although the combination of Design Board Professional and a 2-D program allows the preparation of working drawings from a 3-D model, it does not allow the type of 3-D production drafting that large systems provide, where orthographic views, perspectives, and isometric views can be displayed simultaneously and used as creation spaces interchangeably.

MEGA CADD and VersaCAD have announced a joint distribution agree-

ment to afford users the benefits of having a single source for the complete 2-D/3-D CAD software system. The arrangement does not involve any special products—both Design Board Professional and VersaCAD are the same product whether purchased from separate sources or a single source.

3-D MODELING LEADER

Design Board Professional is an excellent conceptual modeling tool. The availability of perspective views at the stroke of a key enhances the modeling process by making it more interactive. For some designers, this may be the only CAD tool required. For others, the program will be one component in a system, handling the conceptual modeling task, while another program handles the production drafting. Given this philosophy, the only omission from the package is a color shading facility. The automatic saving of a file when the program is exited also would be a simple but valuable addition to the package. The risk of losing unsaved data is too great in the product's present form.

Although Design Board Professional's wire frame modeling facility does not provide the appealing images associated with solid modelers, it allows the construction of complex wire frame models that are easily converted to working drawings or plotted in a variety of views. Drawing files are limited in size because the drawing is in RAM. However, the limits are adequate for the conceptual or schematic modeling of most large projects. With the use of techniques described in the manual, complex models can be created in modules and plotted on the same sheet for simultaneous presentation.

In addition, Design Board Professional is ideal for the creation and presentation of details as a supplement to working drawings created with the production drafting system. Wire frame drawings can be used to illustrate assemblies of parts in see-through form and with exploded views. Such illustrations are difficult to produce with a 2-D package, but are relatively straightforward using Design Board.

A Design Board Professional 3-D modeling system based on a PC, XT, or AT can be assembled for less than $10,000. A complete system—large plotter, digitizer, and a production drafting program—should not exceed $20,000.

Creating simple models is a snap; creating complex models, especially those that require substantial use of the MODIFY screen, is not so simple. Like any powerful program, Design Board Professional demands considerable effort and regular use before achieving its full potential.

The product is obviously aimed at architects, consulting engineers, and planners—judging from the models furnished with the package—but the syntax of commands and terminology used in the manual is general enough to be applicable to designers in any field.

MEGA CADD seems intent on being the leader in the 3-D modeling field. Design Board Professional 2.04 is a significant improvement over its predecessor, and all indications are that more improvements are yet to come.

Design Board Professional: $1,750
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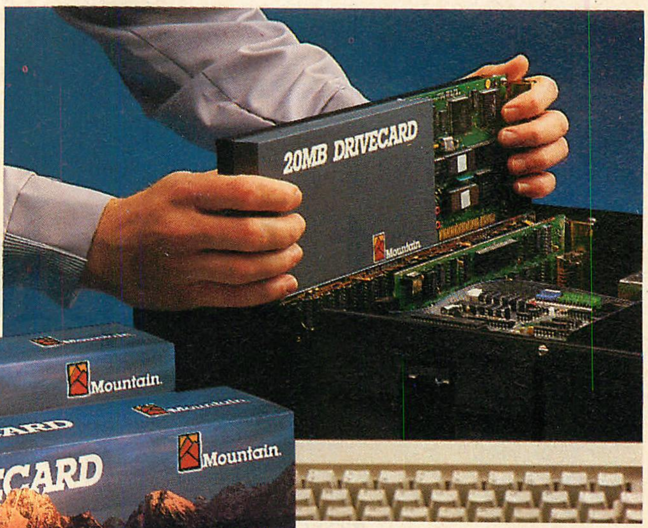

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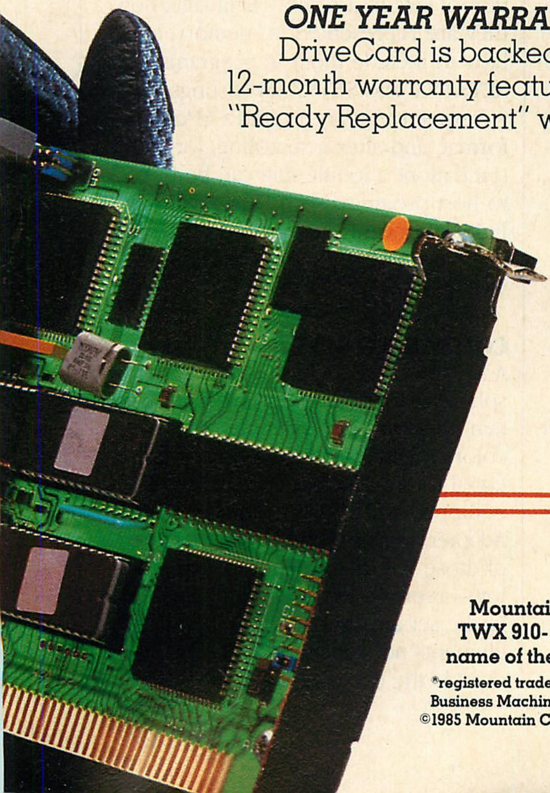

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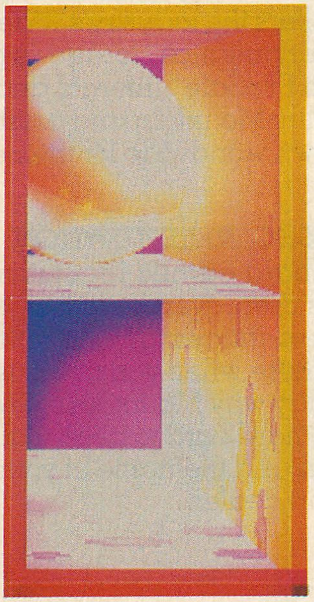
Set Implementation

TOM SWAN

Made popular in Pascal, sets also can be used in assembly language programs to help the user simplify many applications.



The use of sets in assembly language programming holds some pleasant surprises. When sets are added to an 8086/88 subroutine library, for example, they reduce the size and increase the running speed of the programs. The added value of sets and set operators is illustrated in the following simple example: A programmer needs to input a character from the keyboard and test if the character typed is a digit 0 to 9 or a capital letter *A* to *Z*. If any other character is entered, an error routine should be called, otherwise the program should continue. One method often used for this operation in 8086/88 programs is shown in figure 1.

Although the program works correctly, continuing only if a legal character is typed, this approach should be avoided for several reasons. First, the logic may be difficult to follow. Unless the code is studied thoroughly, the purpose of, say, the third jump may not be clear. Second, a knowledge of the underlying character set is assumed. In ASCII, the binary values for the characters 0 to 9 are less than those for *A* to *Z*. With another character set, this might not be true, and the program would fail. Third, tests for additional character ranges would increase the length of the program, making the code more difficult to understand and more prone to catching a bug.

All of these problems can be avoided with the use of sets. By declaring a set of the legal characters expected by the program, the example can be rewritten as in figure 2.

Besides improving the clarity of the program, additional characters can be tested without increasing the size of the test or slowing it down. With sets, not a single byte is added. (The size of a set in memory, as will be shown, does not depend on the number of elements it contains.) Also, the improved program assumes nothing about the underlying binary character values.

This article deals with the construction of sets in assembly language, how they are represented in memory, and how to include them in programs. SETS.EXT and SETS.ASM (listings 1 and 2, respectively) are in IBM's MASM format, and after assembling, form a stand-alone module that can be linked to host programs with DOS LINK. The linking process is explained with a test program, SETTEST.ASM (listing 3), also written in MASM format.

COMPARING SETS

A set can be thought of as a box or sphere that can contain objects of a certain *base type*. For example, a set of colors might exist with a base type equal to the 16 colors available on a PC equipped with IBM's Color Graphics Adapter. Figure 3 shows a set of three of those colors—green, red, and yellow—represented by a circle. Elements in the set are located inside the circle; elements not contained in the set are outside the circle. All available colors

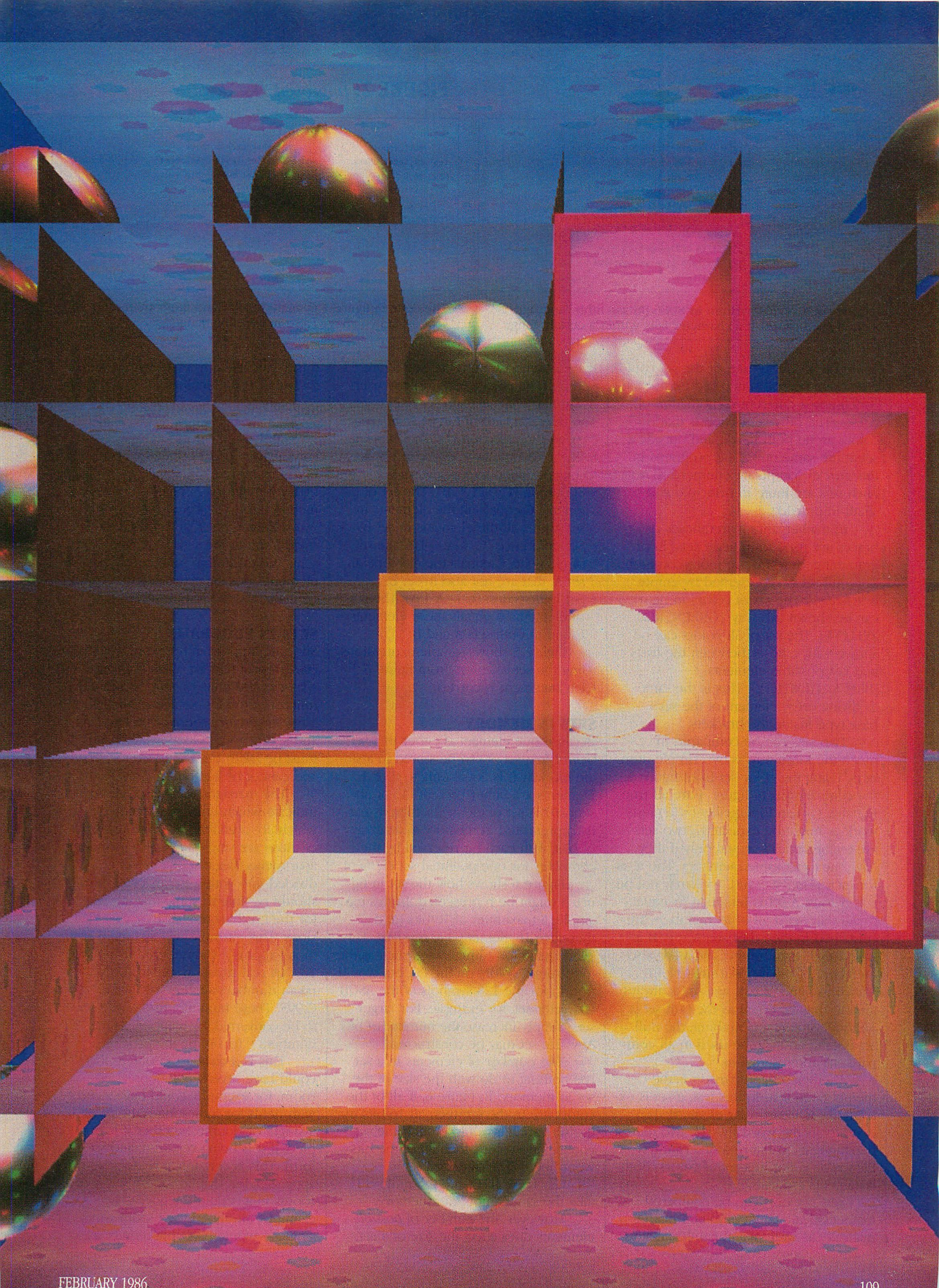


FIGURE 1: *Sample Test Code*

```
begin:
     call input          ;get character into dl register
     cmp  dl,'0'         ;is it less than 0-9, A-Z?
     jb   begin          ;if yes, repeat
     cmp  dl,'9'         ;is it in 0-9 range?
     jbe  continue       ;if yes, jump to continue
     cmp  dl,'A'         ;is it less than A?
     jb   begin          ;if yes, repeat
     cmp  dl,'Z'         ;is it in A-Z range?
     ja   begin          ;if no, repeat, else continue
continue:
```

Code such as this, written in 8086/88 assembly language, is often used to test if a character falls within a certain range.

FIGURE 2: *Improved Test Code*

```
begin:
     call input               ;get character into dl
lea  di,legal_chars      ;address set of legal characters
mov  ah,0                ;prepare for set membership test
     call sets                ;test if dl is in set
     jne  begin               ;if no, repeat, else continue
continue:
```

The code in figure 1 is made smaller and faster by the use of sets, as shown above (also in assembly language).

could be inside the set, or the set could be empty. Several sets could exist, each containing a different combination of colors. The only restriction is that no color can be both inside and outside a set at the same time. The programs in this article manipulate enumerated sets. Such sets are finite in principle and small in practice.

In mathematics, parentheses or braces are used to indicate sets; in programming, brackets are more common. The null set is represented by empty brackets: []. The set of colors in figure 3 can be shown this way: [GREEN, RED, YELLOW]. The set of all colors can be shown with ellipses between the first and last possible elements: [BLACK...HI-WHITE]. This is the same as listing every element of the set's base type inside the brackets.

Two sets can be compared in much the same way as two simple numbers. Using the color set from figure 3, the comparisons in figure 4 are all true. Equality (=) and inequality (<>) tests work as might be expected—two sets are mathematically equal only if they have the exact same members. The tests for inclusion (<= and >=) may not be so obvious. A set is less than or equal to another set if all of its members are contained in the other set: A <= B is true only if the members of A are also members of B—if A is a subset of B. Notice in figure 4 that any set is always greater than or equal to the null set []. Although it contains nothing, the null set is valid and can be used in all comparisons and operations.

Another set comparison is the membership test. In this test, a set is examined for a particular element; the operator is the word IN. The two membership tests in figure 4 determine if RED is or is not in a set of colors. Both statements are true.

Sets not only can be compared mathematically, but combined mathematically as well. Again, familiar mathematical symbols are used (see figure 5). Some of the results may surprise users unfamiliar with sets and set operators. The operators are union (+), difference (−), and intersection (*). They work as follows (assume two sets, A and B, are to be combined into a new set C):

- Set union (C = A + B). The set of elements C equals all the elements in set A plus all the elements in set B.
- Set difference (C = A − B). The set of elements C equals the elements in set A, that are not also in set B.
- Set intersection (C = A * B). The set of elements C equals those elements found in both sets A and B.

Figure 5 shows sample expressions using the set of colors from figure 3. Each statement is correct.

SETS IN MEMORY

Because one element is either in a set or *not* in a set, it can be stored in a single bit, which is equal only to 0 or 1. Elements are either present (1) or absent (0). A set of elements, then, is easily represented in memory as an array of bits, with each bit reserved by the computer for one potential set element.

Figure 6 shows how the set in figure 3 might be represented. In this example, a maximum of 16 bits (and therefore 16 elements) is possible. This is adequate for a limited set, such as the foreground colors on the PC, but would not do for the 128 symbols of the ASCII character set, for example. For larger sets, simply increase the number of bits. Any size set may be constructed.

The number of elements in a set has nothing to do with the size of the set in memory. In figure 6, if all of the colors are in the set, then all 16 bits in the set variable would be 1. If the set contains no colors, then all of the bits would be 0. The saturated set [BLACK...Hi-WHITE] and the null set [] take the same amount of memory.

However, the number of *possible* elements does affect the size of a set; this is calculated in bytes with a simple formula for n elements:

$$\text{bytes} = ((n - 1) \text{ div } 8) + 1$$

Applying this formula, a set of any combination of 256 elements, numbered from 0 to 255, would take 32 bytes of memory. Similarly, 512 elements (0 to 511) would occupy 64 bytes. Remember that n, called the *cardinality* of the set's base type, represents the maximum number of possible elements, not the actual number of elements contained in one set variable.

SETS IN PROGRAMS

Suppose a programmer were writing a custom program for a motel manager who has 190 units to rent. Some of the units are doubles, some are singles, and a few are luxury rooms with kitchens and sitting areas. Occasionally, a unit must be taken out of service for repairs and cannot be rented.

The manager wants a quick way to indicate which units are occupied and which are available, and further, which of those are singles, doubles, or luxury apartments. Because the motel is divided into wings, the manager also should be able to show this information for the north, south, east, or west divisions. This example will assume that the motel rooms are numbered from 0 to 189. (A real situation might involve room numbers such as A-15N and C-99S. These numbers first would have to be converted, or mapped, to the numbers 0 to 189 by the program.)

This is a database problem that could have several solutions. Each room, for example, could have a record with fields for indicating if the room is a single or double, whether it is occupied, if it is being repaired, and so forth. This is certainly a reasonable approach, but displaying the status of all rooms in a certain category—for example, all unoccupied south wing singles—would probably require a

sequential search of the database. With sets the data are available instantly, and the programming is greatly simplified.

Set variables are needed for each category. Figure 7 shows how this might be programmed in assembly language. A set data type is defined as a 32-byte variable using the assembler's STRUCT operator. Then variables for NORTH, SOUTH, EAST, WEST, SINGLES, DOUBLES, LUXURY, and OCCUPIED are defined and included as part of the program's data segment.

If the manager enters a command to display all unoccupied singles in the south wing, the Pascal fragment in figure 8 shows how the request could be satisfied. (It is sometimes helpful to express ideas in a structured language, such as Pascal, before writing an assembly language program—a welcome change to flow charts.)

Yet, an even easier and faster way to satisfy this request calls on the set intersection and difference operations. A new set can be formed that satisfies the search argument "in the south wing, single, and unoccupied." The expression is written in this way:

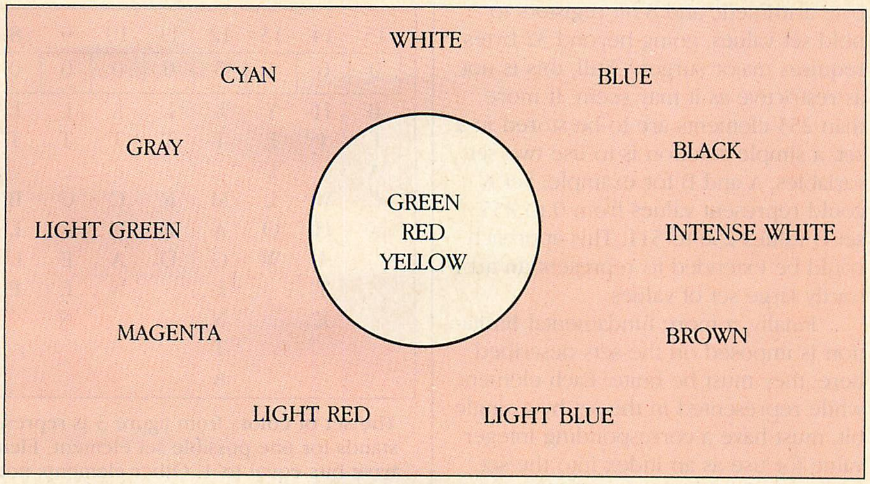
TEMP = (SOUTH * SINGLES) –
OCCUPIED

That is, TEMP is the set of room numbers whose members are in both sets SOUTH and SINGLES, but are not in the set of OCCUPIED rooms. This expression, coded in an assembly language fragment, is listed in figure 9. Considering the conventional database programming required to produce the same results—opening a file, reading each record, and testing various fields stored in the record—the use of sets reduces the amount of writing necessary.

LIMITATIONS

Some other searches may not be as easily accomplished with sets. For example, the motel manager undoubtedly would want to keep a list of the reservations for certain types of units, listing starting and ending dates, along with the names of the persons who made the reservations. While sets are useful for recording a variety of limited attributes, they are not as good for recording names and addresses, telephone numbers, and dates. (Even if it were possible, constructing the set of all persons in the country or world, and then assigning a reservation bit to each in a set variable would hardly be practical.) The point is that, while all data can be represented as belonging to a set of a certain class, some are more practically dealt with using sets than others.

FIGURE 3: *A Set of Colors*



A set of three colors, green, red, and yellow, is represented above by location within a circle. Other colors not in the set are located outside the circle.

FIGURE 4: *Testing Sets*

EQUALITY
[BROWN, LIGHT RED] = [BROWN, LIGHT RED]
[BROWN, LIGHT RED] <> [WHITE, LIGHT RED]
SUBSETS
[BLACK, GREEN] <= [BLACK, BLUE, GREEN]
[BLACK, BLUE, GREEN] >= [ ]
MEMBERSHIP
(RED IN [RED, WHITE, BLUE])
NOT (RED IN [BLUE, GREEN])

Above are six true statements about sets of colors using the elements available in figure 3. A <= B means that A is a subset of B and A >= B means that B is a subset of A. The [ ] represents a set with no members (the null set).

FIGURE 5: *Operations on Sets*

SET UNION (C = A + B)
[RED, WHITE, BLUE] = [RED, WHITE] + [RED, BLUE]
SET DIFFERENCE (C = A – B)
[WHITE] = [RED, WHITE, BLUE] – [RED, BLUE]
SET INTERSECTION (C = A * B)
[RED, BLUE] = [RED, WHITE, BLUE] * [RED, GREEN, BLUE]

The SETS.OBJ module provides these operations, the set comparisons of figure 4, and three others as well: create a set, copy a set, and add an element to a set.

For example, if a set could contain 32,768 elements, it would take 4KB of memory (4,096 bytes by the formula presented earlier) even if the set contained only one element. Such a representation might be economical in some applications (a specialized database, for example) but practically speaking, sets of those dimensions are seldom useful. Keeping in mind the goals of reducing memory and increasing speed, a more reasonable limit for sets must be found. (Arbitrary limits can be set on the maximum number of bytes. Sets that are limited to 32 bytes would have a maximum of 256 elements—a practical amount. It is also common to see maximums of 512 and 128 elements, 64 and 16 bytes, respectively.)

Decreasing the 32-byte set size is easy. For example, if no values greater than 127 are inserted, a 16-byte set variable could be used; values no greater than 31 will fit into 4 bytes and so on.

Increasing set size, however, is more difficult. Because SETS.ASM uses byte arithmetic and 8-bit registers to hold set values, going beyond 32 bytes requires major surgery. Still, this is not as restrictive as it may seem. If more than 255 elements are to be stored in a set, a simple solution is to use two set variables, A and B for example. Set A could represent values from 0 to 255, set B values 256 to 511. This approach could be extended to represent an arbitrarily large set of values.

Finally, a more fundamental limitation is imposed on the sets described here: they must be finite. Each element, while represented in the set by a single bit, must have a corresponding integer value for use as an index into the set. For example, the color MAGENTA might be given the value 4 in an equate statement, with other colors given other values (refer to figure 6). Another suitable base type is the ASCII character set, numbered from 0 to 127 (extended to 255). However, the set of all positive integers, numbered from 0 to infinity, would be unsuitable. Clearly this is out of the finite memory range of the computer (even those with extra RAM cards installed). A subset of integers from 0 to 31, for example, could be programmed. The user will find it helpful to keep such limitations in mind when designing programs that use sets.

FIGURE 6: *Sets in Memory*

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0
BLACK	HI.WHITE	YELLOW	LT.MAGENTA	LT.RED	LT.CYAN	LT.GREEN	LT.BLUE	GRAY	WHITE	BROWN	MAGENTA	RED	CYAN	GREEN	BLUE

The set of colors from figure 3 is represented as a 16-bit word in memory. Each bit stands for one possible set element. Elements in the set [GREEN, RED, YELLOW] have bits equal to 1. Other elements not in the set have bits equal to 0.

ASSEMBLING SETS.ASM

The SETS module in listings 1 and 2 contains procedures for adding sets to assembly language programs. First type in SETS.EXT and SETS.ASM with a text editor (or download the files from PCTECHline). The command MASM SETS; will assemble both into the SETS.OBJ module. This module is a set of subroutines that cannot be run directly—do not link it yet. In order to use the procedures in the module, a host program must be written and assembled; the resulting code is then linked to SETS.OBJ.

Although this may seem like a lot of trouble, the advantage to this approach is that SETS.ASM never has to be assembled again. Any number of host programs can be written and linked to the SETS.OBJ file. Furthermore, because the programming in the module does not have to be reassembled, host programs will assemble faster than they would if the sets procedures were included directly in the assembly language text. If a change is made to the sets module, however, the programs will have to be reassembled and a new SETS.OBJ file created.

SETTEST.ASM is a sample host program that demonstrates how to use the sets module procedures. Check to see that SETS.EXT and SETS.OBJ are in the same directory and assemble SETTEST. Before running the test, link the resulting SETTEST.OBJ file with the sets module as follows with the command LINK SETTEST+SETS;. (This program *cannot* be converted to a .COM file.)

To run the test, enter SETTEST. The program will provide three strings of characters, one string at a time. Type all the letters and digits displayed for each string. If any extra characters (that are not shown) are typed accidentally, that test will have to be repeated. In addition, the upper- and lowercasing of letters is significant, but characters may be entered in any order. The characters typed must correspond exactly with the characters that appeared on the screen before the program will continue. After three tests have been performed, the example program ends.

This somewhat contrived example uses nearly all of the programming in the sets module. The first part of the program, and the main body beginning at SETTEST, are standard for 8086/88 programs, and should be easy to follow. The PRINT procedure displays a string addressed by register SI. PRINT contains an internal subroutine, NEWLINE, that is called separately to display blank lines.

Procedures TEST and REPORT both make good use of sets. In TEST, the two set variables CHSET and DONESET are declared using the set<> structured data type (declared in the SETS.EXT include file). The only input to TEST is register SI, which must address the string of characters to be used in this typing test. Only when all characters in that string are entered—in any order—will the test end. The string must begin with a byte that indicates its length.

After displaying the string addressed by SI, TEST uses set function 4 to create DONESET, which contains a set of all the characters in the string. Next, CHSET is nulled with a call to set function 10. The main loop of the TEST procedure begins at the label TEST1:. DOS function 1 is called to get and echo a character from the keyboard. With set function 8, this character is inserted into CHSET. As the loop repeats, the set of all characters entered by the user is collected in CHSET.

The test ends when all characters entered are found in DONESET (when DONESET is found to be a subset of CHSET), ignoring any extra characters typed. Notice how registers SI and DI are reversed before set function 6, the inclusion test, is called (just after the label TEST1:). If CHSET were tested as a subset of DONESET, the test would either end immediately (after a single correct character) or continue forever (if the first character were incorrect). A check can be performed by removing the two **xchg si,di** instructions.

The REPORT procedure also uses sets to display the accuracy of keyboard typing. It assumes that DONESET equals the set of expected characters for the test, and CHSET contains those characters plus any extra characters typed. The extra characters are easily extracted from CHSET by finding the difference of CHSET − DONESET using set function 2. Printing these characters is accomplished with a simple loop beginning at label REP1: with the set membership test. An ERROR flag indicates the presence of extra characters in CHSET. If none is present, *Done* is displayed. REPORT passes the zero flag ZF

FIGURE 7: *Creating Set Variables*

```
SETLEN    EQU  32
SET       STRUC
          DB   SETLEN DUP(0)
SET       ENDS

DSEG      SEGMENT PARA PUBLIC 'DATA'

NORTH     SET<>
SOUTH     SET<>
EAST      SET<>
WEST      SET<>
SINGLES   SET<>
DOUBLES   SET<>
LUXURY    SET<>
OCCUPIED  SET<>

DSEG      ENDS
```

One way to create set variables in assembly language is to use the assembler's STRUC operator to create a 32-byte data type named SET, and then declare labeled variables of that type in the program's data segment.

FIGURE 8: *Sample Pascal Code*

```
for UNIT := 0 to 189 do
   begin
      if ( UNIT in SOUTH ) and
         ( UNIT in SINGLES ) and
         ( not ( UNIT in OCCUPIED )) then DISPLAY_UNIT_NUMBER
end;
```

This Pascal fragment is used to visualize the operations that are necessary to performing a search in assembly language.

FIGURE 9: *A Set Expression in Code*

```
LEA  SI,SOUTH          ;ADDRESS SOUTH SET WITH SI
LEA  DI,SINGLES        ;ADDRESS SINGLES SET WITH DI
MOV  AH,3              ;SELECT SET INTERSECTION
CALL SETS              ;SINGLES <- (SOUTH*SINGLES)
LEA  SI,SINGLES        ;ADDRESS SINGLES SET WITH SI
LEA  DI,OCCUPIED       ;ADDRESS OCCUPIED SET WITH DI
MOV  AH,2              ;SELECT SET DIFFERENCE
CALL SETS              ;OCCUPIED <- (SINGLES-OCCUPIED)
```

(SOUTH*SINGLES) − OCCUPIED is coded above in assembly language, using procedures 2 and 3 from SETS.OBJ.

back to the TEST procedure, which repeats the last test until only the expected characters are entered.

This test could be used as a shell for user-written programs—just remove procedures PRINT, TEST, and REPORT. Two macros simplify calls to DOS and to the sets module. To call a DOS function, use DOSFN *n* where *n* is any DOS function number. To call a set function, use SETFN *n*, where *n* is a set function number, 0 to 9.

SETS MODULE PROCEDURES

Each procedure of the SETS module is listed below with its necessary parameters (refer to listing 1) and other information. To call a procedure, place a selection code in register AH, set the appropriate parameters, and call SETS. A macro can be used, as shown in SETTEST.ASM. After calling SETS, the results of the operation can be tested. All registers are preserved by the sets module. (The := symbol indicates assignment to the variable on the left from the expression on the right.)

(AH) = 0 Set membership. (V IN SET) Set ES:DI to the address of a set variable, and place an 8-bit test value in DL. On return, if ZF=1 (use jz), then the value in DL was not found in the set. If ZF=0 (use jnz), then the value was found.

Membership is easily determined by isolating the position of the bit in the set for the value being tested. This is done with a call to local procedure SETCALC, which returns AL with the byte containing that bit, AH with the bit in its relative position in that byte, and BX as an offset into the set where that byte is located. After that, membership is determined by TESTing the bit in AL with the byte in AH, setting flag ZF if the bit is equal to 1.

(AH) = 1 Set union. (SET2 := SET1 + SET2) Set DS:SI to the address of SET1, and ES:DI to the address of SET2. Call SETS to form the union of the two, with the results replacing SET2. Set union is the logical OR of all bytes in the sets from which the union is formed. By ORing all bytes, all bits equal to 1 in both sets are transferred to SET2.

(AH) = 2 Set difference. (SET2 := SET1 − SET2) Set DS:SI to the address of SET1, and ES:DI to the address of SET2. Call SETS to form the difference of the two sets, with the results replacing SET2.

Set difference is the logical AND of the complement of all bytes in the set being subtracted from SET1. The programming of set difference can be described this way: for each byte in SET2, complement one byte, AND the result with the same byte in SET1, and store the result back in SET2. Complements are formed by the exclusive ORing of bytes with FFH.

(AH) = 3 Set intersection. (SET2 := SET1 * SET2) Set DS:SI to the address of SET1, and ES:DI to the address of SET2. Call SETS to form the intersection of the two, with the results replacing SET2.

Set intersection is simply the logical AND of all bytes in both sets from which the intersection is formed. By ANDing all bytes, only bits equal to 1 in both sets are transferred to the result.

(AH) = 4 Make set from string. (SET := [S(1),S(2),...,S(n)]) Set DS:SI to the address of the first byte of a string of any 8-bit values. The first byte of the string must be the length of the string, followed by that many characters (or other values). Set ES:DI to the address of a destination set. This function creates a new set equal to the set of all characters in the string. Any values previously in SET are lost. Values are inserted into the set by ORing the appropriate bits into the destination set.

(AH) = 5 Make set alternate. (SET := SET + [S(1),S(2),...,S(n)]) Use the same parameters as in function 4. Each value in the string is inserted into SET, but values already in SET are not removed. This is equivalent to the union of a set with the set of characters in the string.

(AH) = 6 Set inclusion. (SET1 <= SET2) Set ES:DI to the address of SET1, and DS:SI to the address of SET2; this is the reverse sense of many operations. Use this function to determine if SET1 is a subset of SET2. Be careful to assign SI and DI in the correct order.

Set inclusion is found by forming the logical AND of all bytes in both SET1 and SET2, then checking if the result is unchanged from the original values in SET1. The logical AND of the bits in SET1(n) with SET2(n) will equal the bits in SET1(n) only if all bits also are found in SET2(n). That is, for SET1 to be a subset of SET2, all elements of SET1 also must be present in SET2.

(AH) = 7 Set comparison. (SET1 = SET2) Set DS:SI to the address of SET1, and ES:DI to the address of SET2. Call SETS to compare the two set variables. No changes are made to SET1 or SET2. The sets module returns the ZF flag which can be tested as follows:

(ZF = 1) (SET1 = SET2) (use JE)
(ZF = 0) (SET1 <> SET2) (use JNE)

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Set comparison is easily accomplished by comparing all bytes in both sets. Because SI and DI are used to address the set variables, this can be done quickly in 8086/88 assembly language using the CMPSB (compare string byte) instruction with a repeat prefix, REPZ. A word comparison (CMPSW) was not used on the chance that a future version of SETS would not have an even number of bytes in set variables. The comparison would be twice as fast, however, if CMPSW were used. In that case, CX would have to be set to half the byte length of a set variable.

(AH) = 8 Add element. (SET := SET + [ELEMENT]) Set ES:DI to the address of a SET variable. Place any 8-bit value in DL and call SETS to add that value to the SET. No existing members of the set are disturbed. If the element is already in the SET, then this function has no effect. This operation is equivalent to the union of one set with a set that contains only one element.

Adding an element to a set is similar to testing for membership (function 0), except that the logical OR of the appropriate bit is stored directly in the result instead of setting the ZF flag.

(AH) = 9 Copy set. (SET1 := SET2) Set DS:SI to the address of the source set (SET2), and ES:DI to the address of the destination set (SET1). Call SETS to copy the source to the destination set.

A very fast copy is possible using the 8086/88 MOVSB instruction to move the byte addressed by DI directly to the byte addressed by SI, without going through an intermediate register. Also, a repeat prefix REP makes it possible to copy the entire set with a single, although repeated, instruction.

(AH) = 10 Make null set. (SET := []) Set ES:DI to the address of a set variable. Call SETS in order to make that set equal to the null set.

Nulling a set is accomplished by setting all bytes in the set equal to 0. This is done as quickly as possible with the use of a repeat prefix in front of the STOSB (store string byte) instruction as shown in the listing.

These procedures enable programmers to add sets to assembly language programs and to make use of features normally found only in higher-level languages. Judicious use of set comparisons, set operators, and set membership tests can reduce program size while increasing running speed.

Tom Swan runs Swan Software, a consulting business. He has written four books published by the Hayden Book Company, most recently, Pascal for Data Base Management.

LISTING 1: SETS.EXT

```
;SETS.EXT
;External declarations

;-----------------------------------------
;       Equates
;-----------------------------------------
setlen  equ     32                      ;bytes in one set

;-----------------------------------------
;       Type declarations
;-----------------------------------------
set     struc                           ;all new sets are empty
        db      setlen dup(0)
set     ends

;-----------------------------------------
;       External declarations
;-----------------------------------------
if host
        extrn   sets:near
endif
```

LISTING 2: SETS.ASM

```
page 60,132
title   Sets 1.01
;------------------------------------------------------------
; Program       : Sets (Set handling package)
; Version       : 1.01
; System        : IBM PC DOS 2.00+
; Language      : IBM 8088/86 Macro Assembler
; Author        : (C) 1984 by Tom Swan
; Address       : Swan Software  P.O. Box 206  Lititz PA  17543
;------------------------------------------------------------
true    equ     -1
false   equ     0
host    equ     false                   ;true for host program only
maxfn   equ     10                      ;maximum function number
;------------------------------------------------------------
;
; * All sets are composed of 32 bytes.  each bit represents
;   one of 256 values in the set.  If the bit = 1, that value
;   is in the set, else that value is absent.
;
; * Except for flags, all registers are preserved.
;
; * Set routines are called by placing a selection value in ah and
;   calling "sets".  See individual routines for exact parameters.
;
;     example:  mov  dl,value           ;value to test
;               lea  di,anyset          ;address first byte in set
;               mov  ah,0               ;select set membership test
;               call sets               ;call set routine
;               jnz  success            ;found value in set
;
; * Procedures in the module include:
;
;               (ah) = 0  set membership
;               (ah) = 1  set union
;               (ah) = 2  set difference
;               (ah) = 3  set intersection
;               (ah) = 4  make set from string
;               (ah) = 5  make set alternate entry
;               (ah) = 6  set inclusion
;               (ah) = 7  set comparison
;               (ah) = 8  add single element to set
;               (ah) = 9  copy set to set
;               (ah) = 10  make null set
;
;------------------------------------------------------------
page
dgroup  group   dseg
cgroup  group   cseg
        assume  cs:cgroup, ds:dgroup, es:dgroup, ss:nothing
;-----------------------------------------
;       Code Segment
;-----------------------------------------
```

```
cseg    segment byte public 'code'
        include sets.ext              ;include global equates
        public  sets
sets    proc    near
        cld                           ;clear df (set auto-increment mode)
        push    ax                    ;save all registers
        push    bx
        push    cx
        push    dx
        push    di
        push    si

; Use function number in ah as an offset into a jumptable containing
; the addresses of the various set functions.  Jump to selected function.

        cmp     ah,maxfn              ;test for illegal selector
        ja      setexit               ;exit if ah > 6
        mov     bx,offset jumptable   ;bx=base addr (in cseg)
        mov     al,ah                 ;place function number in al
        xor     ah,ah                 ;zero ah to make word in ax
        shl     ax,1                  ;ax<-ax*2 (16-bit word offset)
        add     bx,ax                 ;bx<-bx+ax forming table address
        jmp     word ptr cs:[bx]      ;jump to routine at cs:[bx]
; All routines jump to here when done.  Restore all destroyed
; registers and return to caller.
setexit:
        pop     si                    ;restore all registers
        pop     di
        pop     dx
        pop     cx
        pop     bx
        pop     ax
        ret                           ;return to caller
sets    endp
page
;----------------------------------------------------
; SETCALC
;----------------------------------------------------
; Purpose      -- calculate word address and bit position
;                 for a set value.
;
; Called by    -- functions 0,4,5,8
;
; Arguments    -- (es:di) = address of set (first word)
;                 (dl) = value (8-bits) to test
;
; Returns      -- (al) = byte from set for value in dl
;                 (ah) = bit in relative position for value
;                 (bx) = offset of word (i.e. at ds:[di+bx])
;----------------------------------------------------
dseg    segment byte public 'data'
bittab  db      01h,02h,04h,08h,10h,20h,40h,80h ;bits 0..7 set = 1
dseg    ends
setcalc proc    near
; byte offset = value div 8
; bit offset = value mod 8
        push    di                    ;save di register
        xor     ax,ax                 ;zero ax so that ah=0
        mov     al,dl                 ;set ax=value dl (16-bits)
        mov     bh,8                  ;set bh=divisor
        div     bh                    ;al <- ax div bh ;ah <- ax mod bh
        xor     bx,bx                 ;zero bx so that bh=0
        mov     bl,ah                 ;bx <- value mod 8 (bittab offset)
        lea     di,bittab             ;address 8-byte bit table
        mov     ah,byte ptr [di+bx]   ;ah <- bit in relative position
        pop     di                    ;restore register (address of set)
        mov     bl,al                 ;bx <- value div 8 (set offset)
        mov     al,byte ptr [di+bx]   ;al <- byte from set for value dl
        ret                           ;return to caller
setcalc endp                          ;end procedure
page
;----------------------------------------------------
; SET0  (ah=0)  set membership        (v in set)
;----------------------------------------------------
; Purpose      -- test for presence of value (v) in set
;
; Called by    -- set jump table
;
; Calls        -- setcalc
;
```

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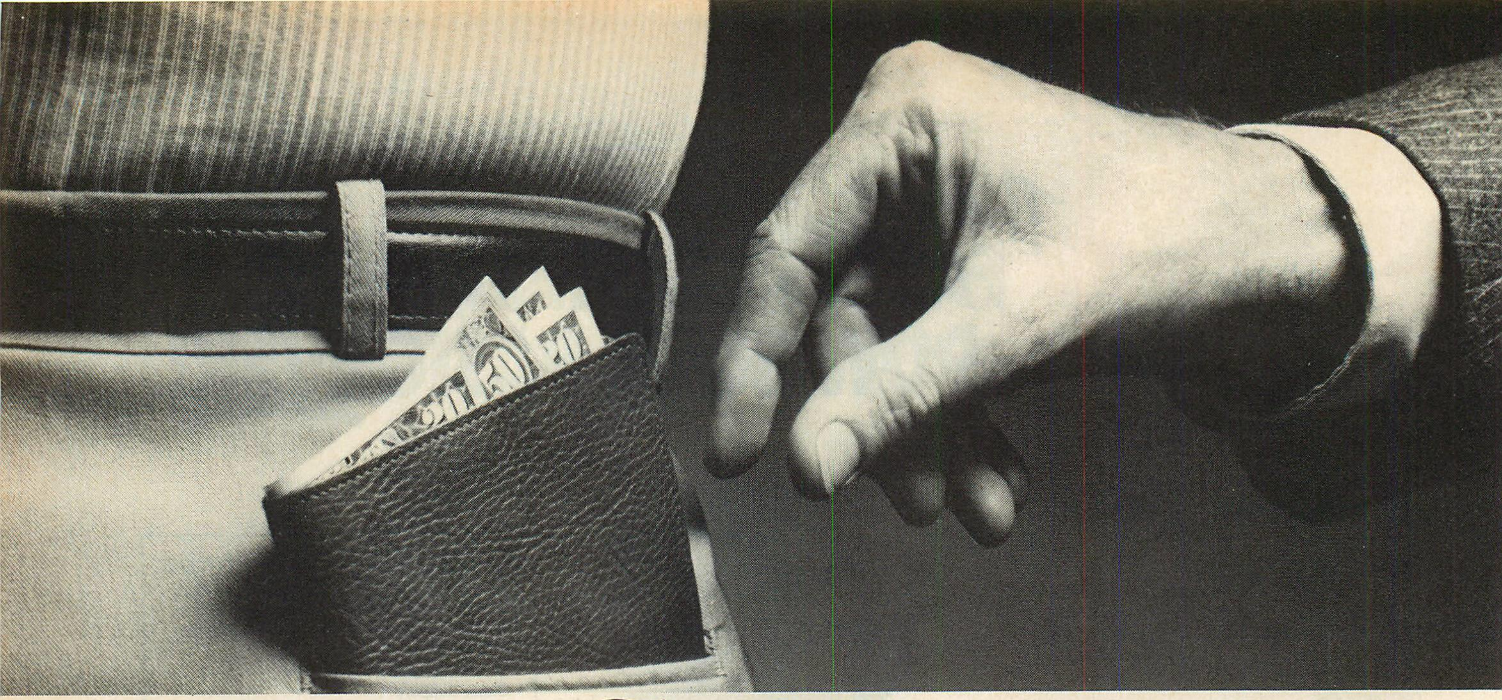
```
        mov     cx,setlen               ;cx=number bytes in set
set3_1:
        lodsb                           ;al<-[si]; si:=si+1
        and     byte ptr [di],al        ;[di]<- logical and of [di],al
        inc     di                      ;advance destination set pointer
        loop    set3_1                  ;loop on cx
        jmp     setexit                 ;end set3
set3    endp
page
;------------------------------------------------------------
; SET4  (ah=4)  make set from string    set <- [s(1),s(2),...,s(n)]
;------------------------------------------------------------
; Purpose       -- insert 8-bit elements from string (s)
;                  into the set.  Assumes first byte of string
;                  indicates length.
;
; Called by     -- main jump table
;
; Calls         -- set5             (via fall-through)
;
; Arguments     -- (ds:si) = address first byte of string (s[0])
;                  (es:di) = address of destination set
;
; Registers     -- none
;------------------------------------------------------------
set4    proc    near
        mov     cx,setlen               ;set cx=number bytes in set
        xor     al,al                   ;set al=0 (value to store in set)
        push    di                      ;save di (set address) on stack

;----- make existing set null

rep     stosb                           ;store al at [di] until cx=0
        pop     di                      ;restore di
                                        ;fall through to set5 procedure
set4    endp
page
;------------------------------------------------------------
; SET5  (ah=5)  make set alternate      set <- set + [s(1),s(2),...,s(n)]
;------------------------------------------------------------
; Purpose       -- add 8-bit elements from string s into
;                  an existing set
;
; Called by     -- main jump table
;                  set4             (via fall-through)
;
; Calls         -- setcalc
;
; Arguments     -- (ds:si) = address first byte of string (s[0])
;                  (es:di) = address of destination set
;
; Registers     -- none
;------------------------------------------------------------
set5    proc    near
        xor     cx,cx                   ;zero cx so that ch=0
        lodsb                           ;get length al<-[si]; si<-si+1
        mov     cl,al                   ;set cx=count of chars in string
        jcxz    set5_2                  ;exit on null string
set5_1:
        lodsb                           ;get byte al<-[si]; si<-si+1
        mov     dl,al                   ;move value in al to dl for setcalc
        call    setcalc                 ;calculate byte offset bx; bit ah
        or      byte ptr [di+bx],ah     ;or bit in ah into set byte
        loop    set5_1                  ;cx<-cx-1; if cx<>0 then loop
set5_2:
        jmp     setexit                 ;end set5
set5    endp
page
;------------------------------------------------------------
; SET6  (ah=6)  set inclusion           set1 <= set2
;------------------------------------------------------------
; Purpose       -- test if set1 is a subset of set2
;
; Called by     -- main jump table
;
; Calls         -- none
;
; Arguments     -- (es:di) = address of set1
;                  (ds:si) = address of set2
;
;
```



```
; Arguments     -- (es:di) = address of set
;                  (dl) = 8-bit value (v)
;
; Registers     -- zf=1 = value not present      (use jz)
;                  zf=0 = value present          (use jnz)
;-------------------------------------------------------------
set0     proc    near
         call    setcalc                 ;ax=value; bx=address; cx=bit
         test    al,ah                   ;test bit in ah against set val
         jmp     setexit                 ;end function 0
set0     endp
page
;-------------------------------------------------------------
; SET1  (ah=1)  set union        (set2 <- set1 + set2)
;-------------------------------------------------------------
; Purpose       -- make set2 equal to all elements in set1
;                  plus elements already in set2.
;
; Called by     -- main jump table
;
; Calls         -- none
;
; Arguments     -- (ds:si) = address of set1
;                  (es:di) = address of set2
;
; Registers     -- none

;-------------------------------------------------------------
set1     proc    near
         mov     cx,setlen               ;cx=number bytes in set
set1_1:
         lodsb                           ;al<-[si]; si<-si+1
         or      byte ptr [di],al        ;[di]<-logical or of [di],al
         inc     di                      ;advance destination set pointer
         loop    set1_1                  ;loop on cx
         jmp     setexit                 ;end set1
set1     endp
page
;-------------------------------------------------------------
; SET2  (ah=2)  set difference          (set2 <- set1 - set2)
;-------------------------------------------------------------
; Purpose       -- make set2 equal to the set of elements of set1
;                  which are not also members of the original set2
;
; Called by     -- main jump table
;
; Calls         -- none
;
; Arguments     -- (ds:si) = address of set1
;                  (es:di) = address of set2
;
; Registers     -- none
;-------------------------------------------------------------
set2     proc    near
         mov     cx,setlen               ;cx=number bytes in set
set2_1:
         xor     byte ptr [di],0ffh      ;complement byte at [di]
         lodsb                           ;al<-[si]; si<-si+1
         and     byte ptr [di],al        ;[di]<- logical and of [di],al
         inc     di                      ;advance destination set pointer
         loop    set2_1                  ;loop on cx
         jmp     setexit                 ;end function 2
set2     endp
page
;-------------------------------------------------------------
; SET3  (ah=3)  set intersection        (set2 <- set1 * set2)
;-------------------------------------------------------------
; Purpose       -- make set2 equal to the set of elements in
;                  both set1 and the original set2
;
; Called by     -- main jump table
;
; Calls         -- none
;
; Arguments     -- (ds:si) = address of set1
;                  (es:di) = address of set2
;
; Registers     -- none
;-------------------------------------------------------------
set3     proc    near
```

```
        mov     cx,setlen               ;cx=number bytes in set
set3_1:
        lodsb                           ;al<-[si]; si:=si+1
        and     byte ptr [di],al        ;[di]<- logical and of [di],al
        inc     di                      ;advance destination set pointer
        loop    set3_1                  ;loop on cx
        jmp     setexit                 ;end set3
set3    endp
page
;--------------------------------------------------------
; SET4  (ah=4)  make set from string    set <- [s(1),s(2),...,s(n)]
;--------------------------------------------------------
; Purpose       -- insert 8-bit elements from string (s)
;                  into the set.  Assumes first byte of string
;                  indicates length.
;
; Called by     -- main jump table
;
; Calls         -- set5         (via fall-through)
;
; Arguments     -- (ds:si) = address first byte of string (s[0])
;                  (es:di) = address of destination set
;
; Registers     -- none
;--------------------------------------------------------
set4    proc    near
        mov     cx,setlen               ;set cx=number bytes in set
        xor     al,al                   ;set al=0 (value to store in set)
        push    di                      ;save di (set address) on stack

;----- make existing set null

rep     stosb                           ;store al at [di] until cx=0
        pop     di                      ;restore di
                                        ;fall through to set5 procedure
set4    endp
page
;--------------------------------------------------------
; SET5  (ah=5)  make set alternate      set <- set + [s(1),s(2),...,s(n)]
;--------------------------------------------------------
; Purpose       -- add 8-bit elements from string s into
;                  an existing set
;
; Called by     -- main jump table
;                  set4                 (via fall-through)
;
; Calls         -- setcalc
;
; Arguments     -- (ds:si) = address first byte of string (s[0])
;                  (es:di) = address of destination set
;
; Registers     -- none
;--------------------------------------------------------
set5    proc    near
        xor     cx,cx                   ;zero cx so that ch=0
        lodsb                           ;get length al<-[si]; si<-si+1
        mov     cl,al                   ;set cx=count of chars in string
        jcxz    set5_2                  ;exit on null string
set5_1:
        lodsb                           ;get byte al<-[si]; si<-si+1
        mov     dl,al                   ;move value in al to dl for setcalc
        call    setcalc                 ;calculate byte offset bx; bit ah
        or      byte ptr [di+bx],ah     ;or bit in ah into set byte
        loop    set5_1                  ;cx<-cx-1; if cx<>0 then loop
set5_2:
        jmp     setexit                 ;end set5
set5    endp
page
;--------------------------------------------------------
; SET6  (ah=6)  set inclusion           set1 <= set2
;--------------------------------------------------------
; Purpose       -- test if set1 is a subset of set2
;
; Called by     -- main jump table
;
; Calls         -- none
;
; Arguments     -- (es:di) = address of set1
;                  (ds:si) = address of set2
;
```

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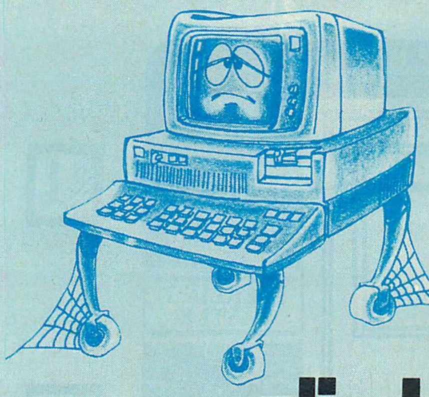

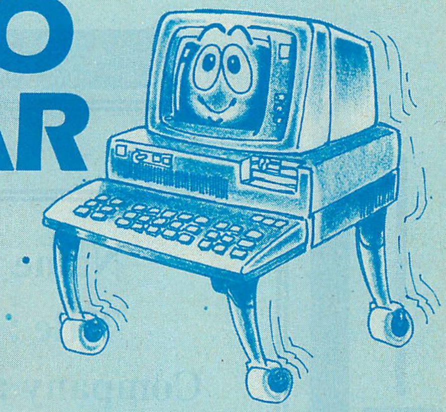

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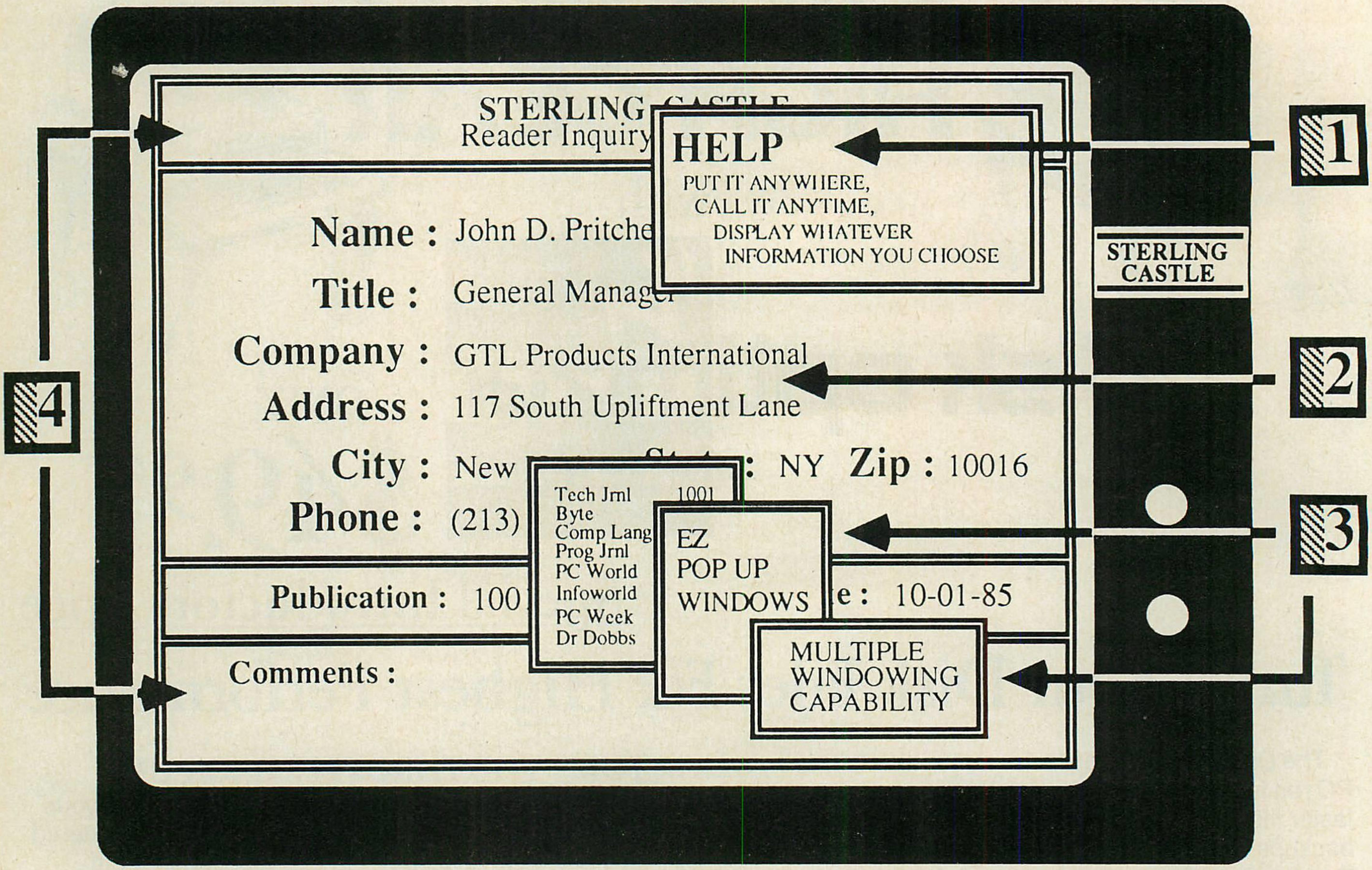

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```
; Registers      -- zf = 1 if set1 <= set2        (use je)
;                   zf = 0 if not (set1 <= set2) (use jne)
;--------------------------------------------------------
set6    proc    near
        mov     cx,setlen               ;cx=number bytes in set
set6_1:
        lodsb                           ;al <- [si]; si := si + 1
        and     al,byte ptr [di]        ;al <- [si] & [di]
        cmp     al,byte ptr [di]        ;compare with original byte
        jne     set6_2                  ;jump on difference found
        stosb                           ;advances di (value [di] unchanged)
        loop    set6_1                  ;loop on cx (flags preserved)
set6_2:
        jmp     setexit                 ;end set6
set6    endp
page
;--------------------------------------------------------
; SET7  (ah=7)  set comparison          set1 = set2
;--------------------------------------------------------
; Purpose        -- test if set1 equals set2
;
; Called by      -- main jump table
;
; Calls          -- none
;
; Arguments      -- (ds:si) = address of set1
;                   (es:di) = address of set2
;
; Registers      -- zf = 1 if set1 = set2       (use je)
;                   zf = 0 if set1 <> set2      (use jne)
;--------------------------------------------------------
set7    proc    near
        mov     cx,setlen               ;cx=number bytes in set
repz    cmpsb                           ;compare [si],[di]
                                        ;loop on cx if equal
        jmp     setexit                 ;end set7
set7    endp
page
;--------------------------------------------------------
;  SET8 (ah=8)  add element      set1 := set1 + [element]
```

```
;--------------------------------------------------------
; Purpose        -- add one element to members of a set
;
; Called by      -- main jump table
;
; Calls          -- setcalc
;
; Arguments      -- (es:di) = address of destination set
;                      (dl) = 8-bit element to add
; Registers      -- none
;--------------------------------------------------------
set8    proc    near
        call    setcalc                 ;calculate byte offset bx; bit ah
        or      byte ptr [di+bx],ah     ;or bit in ah into set byte
        jmp     setexit                 ;end set8
set8    endp
page
;--------------------------------------------------------
; SET9  (ah=9)  copy set        set1 := set2
;--------------------------------------------------------
; Purpose        -- copy one set variable to another
;
; Called by      -- main jump table
;
; Calls          -- none
;
; Arguments      -- (ds:si) = address of set2 (source)
;                   (es:di) = address of set1 (destination)
;
; Registers      -- none
;--------------------------------------------------------
set9    proc    near
        mov     cx,setlen               ;cx=number bytes in set
rep     movsb                           ;copy [di]<-[si] until cx=0
        jmp     setexit                 ;end set9
set9    endp
page
;--------------------------------------------------------
;  SET10        (ah=10) make null set           set1 := []
```

```
;-------------------------------------------------------
; Purpose       -- make a set variable equal to the null set
;
; Called by     -- main jump table
;
; Calls         -- none
;
; Arguments     -- (es:di) = address of set1
;
; Registers     -- none
;-------------------------------------------------------
set10   proc    near
        mov     cx,setlen               ;cx=number bytes in set
        xor     al,al                   ;al <- 0
rep     stosb                           ;store al at [di] until cx=0
        jmp     setexit                 ;end set10
set10   endp
page
;--------------------------------------
;       Jump Table (in code segment)
;--------------------------------------
; following are the addresses of the individual routines in the set
; package.  the list of addresses forms a table for selecting a
; function based on the value in ah.
jumptable:
        dw      set0                    ;fn0-set membership
        dw      set1                    ;fn1-set union
        dw      set2                    ;fn2-set difference
        dw      set3                    ;fn3-set intersection
        dw      set4                    ;fn4-make set
        dw      set5                    ;fn5-add to set
        dw      set6                    ;fn6-set inclusion
        dw      set7                    ;fn7-set comparison
        dw      set8                    ;fn8-add single element
        dw      set9                    ;fn9-copy set to set
        dw      set10                   ;fn10-make null set
cseg    ends                            ;end of code segment
        end                             ;end of text
```

LISTING 3: SETTEST.ASM

```
page 60,132
title   SETTEST.ASM  1.00
;-----------------------------------------------------------
;  Program      : Sets module test program
;  Version      : 1.00
;  System       : IBM PC-DOS 2.00+
;  Language     : IBM 8088 Macro Assembler
;  Author       : (C) 1985 by Tom Swan
;  Address      : Swan Software  P.O. Box 206  Lititz PA  17543
;-----------------------------------------------------------
true    equ     -1
false   equ     0
host    equ     true

;----------------------------------------
;       Code, data, stack groups
;----------------------------------------
dgroup  group   dseg
cgroup  group   cseg
sgroup  group   sseg
        assume  cs:cgroup, ds:dgroup, es:dgroup, ss:sgroup

;----------------------------------------
;       Equates
;----------------------------------------
cr      equ     13                      ;ASCII carriage return
lf      equ     10                      ;ASCII line feed

;----------------------------------------
;       Macro definitions
;----------------------------------------

; Call dos function p1

dosfn   macro   p1                      ;;"dosfn 2" calls dos function #2
        mov     ah,p1                   ;;pass function number in ah
        int     21h                     ;;call dos via interrupt 21 hex
        endm

; Call sets function

setfn   macro   n                       ;;"setfn 8" calls sets function #8
        mov     ah,n                    ;;elect function n
        call    sets                    ;;call sets package (near)
        endm

;----------------------------------------
;       Data segment
;----------------------------------------
dseg    segment byte public 'data'
progid  db      'Set Test Program 1.00',cr,lf
        db      '(C) 1985 by Tom Swan',cr,lf
crlf    db      cr,lf,'$'
donemsg db      cr,lf,'Test completed',cr,lf,'$'

;----- Test strings.  First byte = length.

s1      db      36,'1234567890abcdefghijklmnopqrstuvwxyz'
s2      db      13,'ACEGIKMOQSUWY'
s3      db      13,'BDFHJLNPRTVXZ'

dseg    ends

;----------------------------------------
;       Stack segment
;----------------------------------------
sseg    segment para stack 'stack'
        db      8 dup('**Stack*')
sseg    ends

;----------------------------------------
;       Code segment
;----------------------------------------
cseg    segment byte public 'code'

        include sets.ext                ;include global declarations

settest proc    far
        push    ds                      ;set up far return address on stack
        xor     ax,ax                   ; equal to ds:0000.
        push    ax
        push    ds                      ;save value of segment
                                        ; registers ds,es
        push    es
        mov     ax,dseg                 ;prepare to load ds,es via ax
        mov     ds,ax                   ;set ds=data segment address
        mov     es,ax                   ;set es=data segment address
        lea     dx,progid               ;dx=address program id message
        dosfn   9                       ;print string
        lea     si,s1                   ;test string 1
        call    test
        lea     si,s2                   ;test string 2
        call    test
        lea     si,s3                   ;test string 3
        call    test
        lea     dx,donemsg              ;dx=address done message
        dosfn   9                       ;print string
        pop     es                      ;restore segment registers es,ds
        pop     ds
        ret                             ;execute far return to dos
settest endp
page
;-----------------------------------------------------------
; PRINT / NEWLINE
;-----------------------------------------------------------
; Purpose       -- display test string
;
; Called by     -- test
;
; Calls         -- none
;
; Arguments     -- (ds:si) = address of string at len byte
;
; Registers     -- ax,cx,dx destroyed, si preserved
;-----------------------------------------------------------
print   proc    near
        push    si
        cld                             ;clear df for auto increments
        lodsb                           ;al <- [ds:si]; si <- si + 1
```

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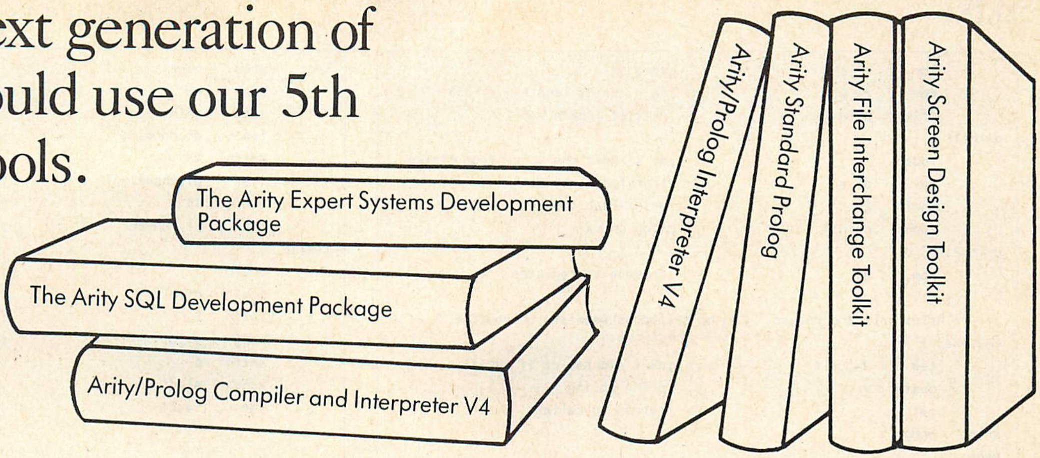

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```
        xor     cx,cx                   ;zero cx
        mov     cl,al                   ;cx = string length 0 .. 255
        jcxz    print2                  ;exit if length = 0
print1:
        lodsb                           ;al <- next character from string
        mov     dl,al                   ;transfer al to dl
        dosfn   2                       ;print char in dl
        loop    print1                  ;loop on cx
print2:
        pop     si                      ;restore si register

;----- Print crlf and return.  Can be called as separate subroutine.
newline:
        lea     dx,crlf                 ;dx = address cr lf ASCII$ string
        dosfn   9                       ;print string
        ret                             ;return to caller
print   endp
page
;-----------------------------------------------------------
; TEST
;-----------------------------------------------------------
; Purpose       -- perform test -- enter characters until
;                  set of characters typed equals expected
;                  set of characters.  Repeat test if any
;                  extra characters are accidentally typed.
;
; Called by     -- main program
;
; Calls         -- sets
;                  print
;                  report
;
; Arguments     -- (ds:si) = address of test string
;
; Registers     -- ax,cx,dx,di destroyed
;-----------------------------------------------------------
dseg    segment byte public 'data'
chset   set<>                   ;set of characters entered
doneset set<>                   ;set of characters expected
dseg    ends
```

```
test    proc    near
        push    si                      ;save si in case test repeats
        call    print                   ;print test string
        lea     di,doneset              ;di = address of doneset variable
        setfn   4                       ;doneset <- set of chars in string
        lea     di,chset                ;di = address of chset variable
        setfn   10                      ;make chset = null set []
        lea     si,doneset              ;preset si = address of doneset
test1:
        dosfn   1                       ;get and echo char (ch in al)
        mov     dl,al                   ;transfer char to dl
        setfn   8                       ;insert dl into chset at (di)
        xchg    si,di                   ;si=chset, di=doneset
        setfn   6                       ;test for doneset <= chset
        xchg    si,di                   ;si=doneset, di=chset
        jne     test1                   ;jump if doneset
                                        ; not a subset of chset

;----- Report results of test, and repeat same test on any errors
        call    report                  ;check and report results
        pop     si                      ;restore si register
        jz      test                    ;repeat test on any errors
        ret                             ;else end test
test    endp
page
;-----------------------------------------------------------
; REPORT
;-----------------------------------------------------------
; Purpose       -- report results of test.
;
; Called by     -- test
;
; Calls         -- newline
;                  sets
;
; Arguments     -- doneset (in test dseg) = expected char set
;                  chset (in test dseg) = chars entered
;
; Registers     -- ax,dx,di,si destroyed
;                  zf = 1 if extra chars entered (use jz)
;                  zf = 0 if entry was perfect (use jnz)
;-----------------------------------------------------------
dseg    segment byte public 'data'
repmsg  db      'Extra chars = ','$'
noerr   db      'none',cr,lf,'$'
error   db      ?
dseg    ends

report  proc    near
        mov     error,false             ;error flag = false
        call    newline                 ;write a blank line
        lea     dx,repmsg               ;prepare to print report message
        dosfn   9                       ;print string
        lea     di,doneset              ;di = address of doneset
        lea     si,chset                ;si = address of chset
        setfn   2                       ;doneset <- chset - doneset
        mov     dl,32                   ;dl = ASCII first char to check
rep1:
        setfn   0                       ;set membership for value in dl
        jz      rep2                    ;jump if dl not a member of doneset
        mov     error,true              ; else flag the error
        dosfn   2                       ; and print the extra character
rep2:
        inc     dl                      ;next char to test
        cmp     dl,128                  ;loop while dl < 128
        jb      rep1
        lea     dx,noerr                ;prepare to print "none" message
        cmp     error,true              ;check error flag
        jne     rep3                    ;jump if no errors detected
        lea     dx,crlf                 ;print crlf if errors found
rep3:
        dosfn   9                       ;print ASCII$ string at dx
        call    newline                 ;write two blank lines
        call    newline
        cmp     error,true              ;set flags before returning
        ret                             ;end test / report
report  endp
cseg    ends                            ;end of segment
        end     settest                 ;end program
```

Microsoft languages speak for themselves.

Loud and clear.

Microsoft has been the language leader from day one. From the world's favorite BASIC to the systems languages software developers prefer. No one else has put so much programming power on so many micros.

Microsoft offers a complete set of languages. Whether you favor the elegance of C, or the power of assembly language. From data munching in COBOL to number crunching in FORTRAN, we've got the power you need.

The advantages of leadership.

Microsoft languages have developed quite a following. They're backed by the largest collection of support libraries you've ever seen. Packages for advanced mathematics and data management. From graphics support to context-sensitive editors. All available today. So you can spend your time solving real problems, not reinventing the wheel.

Microsoft's languages—like C, FORTRAN, Pascal and Macro Assembler—have become the favorites of commercial software developers. It's not surprising. Interlanguage calling allows libraries written in one language to be used with others. Which means your existing routines can be an investment in future projects, not lost time and effort.

Our interactive debuggers are another Microsoft edge. Now you can debug the object code using the source language. Easier debugging lets you spend more time creating.

Pipelines to the future.

Microsoft wrote the book when it comes to operating systems. Nobody knows MS-DOS® or XENIX® better. And our languages show it. We put the latest advances within your grasp. From networking and pipes to multi-tasking, Microsoft languages have the edge you need.

Complete support.

Only Microsoft offers language support this comprehensive. Our clear, thorough documentation, and regular product enhancements are setting new standards in the industry. Add our technical "hotline" and our highly-trained support staff, and you'll reach the same conclusion the industry has: Microsoft languages always lead from strength.

Microsoft C

First with the pros.

"Microsoft C is the cornerstone of all our future development projects. Not only is the code more efficient, we can really exploit the PC's architecture with Microsoft C's NEAR and FAR pointer types."
Ray Ozzie, President of IRIS Associates and key Symphony developer.

"The code optimization is impressive—especially the register declarations."
Jim Bean, Peachtree Software.

When you need code that's small and fast, Microsoft® C is the language.

Our optimizing compiler lets you squeeze the maximum out of your machine with minimum effort. Tighter code runs faster. And virtually every program will run faster with Microsoft's C Compiler than with any other MS-DOS compiler.

Our advanced memory models give you unmatched flexibility. No arbitrary limits on code and data. Use large or small memory models as the application demands. Exclusive features like our NEAR and FAR pointers let you combine different models without sacrificing performance.

Our extensive math libraries are another plus. The floating point package supports 8087 operation when speed is the key. There's also floating point emulation for unendowed PCs. And the altmath package gives you an extra burst of speed when you really need it.

A bundle of other features can save you programming time. There's inter-language calling support. So you can use existing library routines. Unsurpassed XENIX compatibility. And documentation that reviewers have praised for its clarity and thoroughness.

If Microsoft C amazes you, don't be surprised. After all, our C is the choice of the leaders. Companies like Lotus.® Ashton-Tate. And IBM.®

Microsoft C Compiler Version 3.0 for MS-DOS

Microsoft C Compiler
- Produces compact code and fast executables.
- Implements register variables.
- Small, medium and large memory model libraries.
- Can mix models with NEAR and FAR pointers.
- Transport source and object code between MS-DOS and XENIX 286 operating systems.
- Library routines implement most of UNIX™ System V C library.
- Choose from three math libraries and generate in-line 8087/80287 instructions or floating point calls:
  - —Floating Point Emulator (utilizes 8087/80287 if installed).
  - —8087/80287 coprocessor support.
  - —Alternate math package provides extra speed without an 8087/80287.
- Link your C routines with Microsoft FORTRAN (version 3.3 or higher), Microsoft Pascal (version 3.3 or higher) or Microsoft Macro Assembler.
- Supports MS-DOS pathnames and input/output redirection.
- File sharing, record locking and file locking are supported.
- Do source level debugging with the Symbolic Debug Utility, available separately with Microsoft Macro Assembler.

Library Manager
- Create, organize and maintain your object module libraries created with Microsoft languages.

Object Code Linker
- Simple overlay linker combines relocatable object modules created using Microsoft languages into a single program.
- Link very large programs (over 1 megabyte) using overlays.

Microsoft EXE File Compression Utility
- A new utility to compress sequences of identical characters from an executable file and optimizes the relocation table.

Microsoft EXE File Header Utility
- Display and modify EXE file header, allowing you to tune the stack size and initial memory allocation.

Macro Assembler

The quickest. Bar none.

Our Macro Assembler has long been the most complete package on the market. Now it's also the fastest. Three times faster than before. And faster than anyone else. Period.

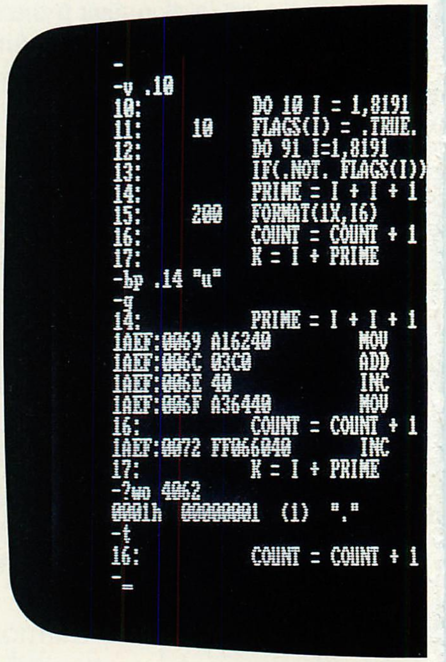
Of course, it's still the most powerful assembler on the market. It supports the standard 8086/8087 opcodes. And the new 186/286/287 instruction set. So you can make the most of the new machines.

Debugging is quicker, too. Thanks to our interactive symbolic debugger, SYMDEB. Now you can refer to variables and source code instead of getting lost in hex dumps. And this debugger also works with Microsoft languages like C, FORTRAN and Pascal. So now you can set breakpoints and trace execution— using source code for reference.

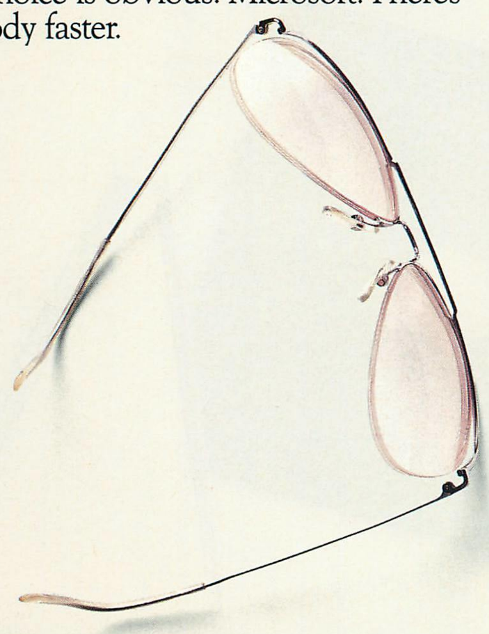
SYMDEB is just part of our complete set of utilities. Tools that make programming as fast as it should be. There are the linker and library managers you'd expect. Plus a new version of MAKE, our maintenance utility, with improvements like macro expansions and inference rules.

We've also revised the manuals. Our new Macro Assembler has a lot to offer, so we added more examples. Now our manuals are not only thorough, they're clearer than ever before.

For quick development and assembly, the choice is obvious. Microsoft. There's nobody faster.



The Macro Assembler's symbolic debugger lets you debug Microsoft FORTRAN programs at either the source or object code level. Set break points, observe the contents of variables and expressions, and examine the contents of the stack.



Microsoft Macro Assembler Version 4.0 for MS-DOS

Macro Assembler
- Fastest macro assembler for MS-DOS computers.
- Supports the 8086/8087/8088 and the 186/286/287.
- Define macros.
- Conditional assembly.
- Optional case sensitivity for symbols.
- 100% upward compatibility from earlier versions of both the Microsoft and IBM Macro Assemblers.

Interactive Symbolic Debug Utility
- Source level debugger for programs written in Microsoft Macro Assembler, C Compiler, FORTRAN, and Pascal.
- Screen swapping helps debug highly visual applications.
- Set breakpoints on line numbers and symbols.
- Single step to follow program execution.
- Disassemble object code.
- Display and modify values.
- Full I/O redirection.

Program Maintenance Utility
- Rebuilds your applications after your source files have changed.
- Similar to UNIX MAKE utility.
- Supports macro definitions and inference rules.

Library Manager
- Create, organize and maintain your object module libraries created with Microsoft languages.
- Set page size from 16 to 32678, to create compact and granular libraries.

Object Code Linker
- Simple overlaying linker combines relocatable object modules created using Microsoft languages into a single program.
- Load Map generation.
- Specify from 1 to 1024 segments.

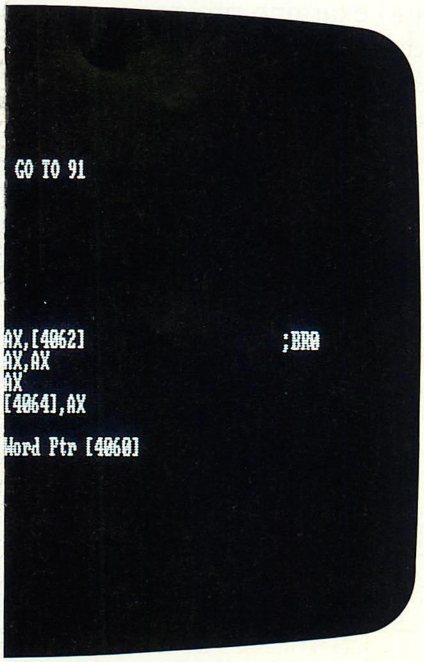
Cross-Reference Utility
- Creates a cross-reference listing of the definitions and locations of all symbols used in an assembly language program, which makes debugging programs easier.

Microsoft EXE File Compression Utility
- Packs EXE files for smaller size on disk and faster loading at execution time.

Microsoft EXE File Header Utility
- Display and modify EXE file header, allowing you to tune the stack size and initial memory allocation.

FORTRAN

The overwhelming favorite.



View the FORTRAN source code. Set a break point at line #14. Run the program **(g)** *and use the expression evaluator* **(?)** *to examine the contents of a variable. Then use the trace command* **(t)** *to observe the program flow.*

Microsoft FORTRAN Compiler Version 3.3
for MS-DOS and XENIX 286

Microsoft FORTRAN Compiler
- Implements most ANSI 77 standard features, plus extensions.
- Easily port mainframe/minicomputer programs with little or no modification.
- Overlay support in the compiler and linker.
- Common blocks and arrays greater than 64K.
- Supported by the largest number of third party libraries.
- Includes a full set of math libraries to select from:
  - 8087/80287 emulation.
  - 8087/80287 coprocessor support.
  - Floating Point without 8087/80287.
  - BCD Floating Point.
- Conditional compilation.
- Link your FORTRAN routines with Microsoft C Compiler (version 3.0 or higher), Microsoft Pascal (version 3.3 or higher), and Microsoft Macro Assembler.
- MS-DOS 3.1 network support and IBM local area network support.
- Source code compatible between MS-DOS and XENIX 286.
- Do source level debugging with the Symbolic Debug Utility, available separately with Microsoft Macro Assembler.

Object Code Overlay
- Simple overlay linker combines relocatable object modules created using Microsoft languages into a single program.
- Link very large programs (over 1 megabyte) using overlays.

Library Manager
- Create, organize and maintain your object module libraries created with Microsoft languages.

Microsoft EXE File Compression Utility (MS-DOS only)
- A utility to pack EXE files for smaller size on disk and faster loading at execution time.

Microsoft EXE File Header Utility (MS-DOS only)
- A utility that allows you to display and modify the fields in EXE file headers.

How did Microsoft FORTRAN get so popular?

It could be the mainframe compatibility. Our compiler makes porting applications a cinch with overlays and the ANSI features you need.

It could be our support for arrays and COMMON blocks larger than 64K. So you can tackle mainframe-size problems.

It might be the shelves and shelves of third party support libraries. No other FORTRAN comes close.

It could be the extensive math support. Our collection of math libraries is simply the largest available. Tackle real problems with direct 8087 support or emulation. Use IEEE floating point or—for extra speed—the altmath package.

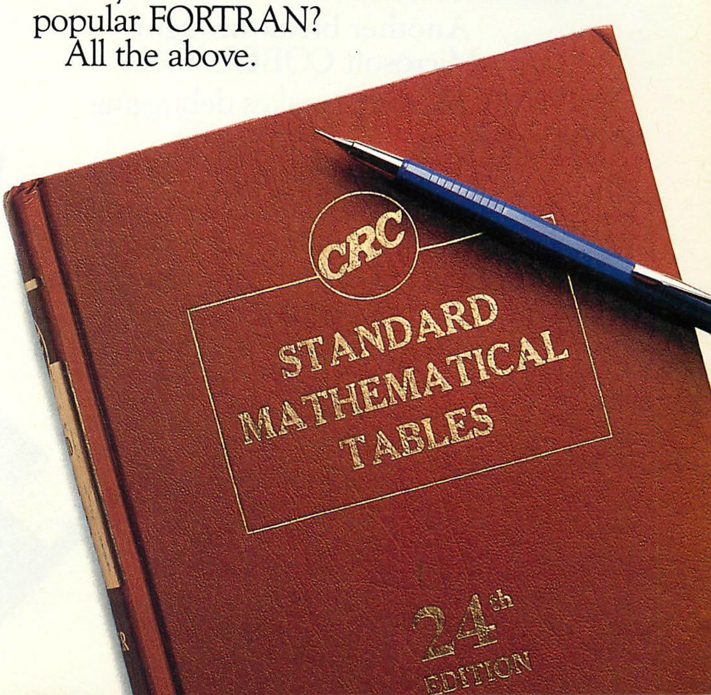
It could be the comprehensive set of utilities. A powerful linker and library manager combination. Plus tools like EXEMOD and EXEPACK. Standard.

It could be the XENIX and MS-DOS source-level compatibility. Or the direct interlanguage calling to Microsoft C, Pascal, and Assembler. Or the ability to work with our Macro Assembler's symbolic debugger.

It could be the value. Nobody offers a FORTRAN package this complete at this low a price.

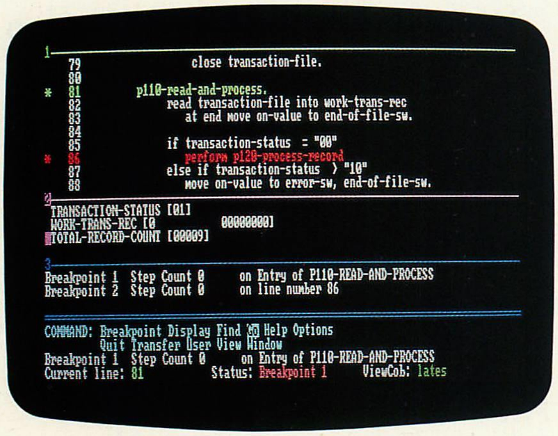
Why is Microsoft FORTRAN the most popular FORTRAN?

All the above.



COBOL

The interactive edge.



Microsoft COBOL gives programs a new look. With dazzling support for interactive programs, and more. Our new COBOL Compiler brings applications to life in several ways.

Our extended screen section lets you create programs that you'd never thought could be written in COBOL. Quickly, easily.

Performance is top notch as well. Our ISAM lets your applications blaze through files. After all, our ISAM is the fastest on the micro market.

Of course, Microsoft COBOL complies with the ANSI standard. Amazing performance, without runtime license fees. No wonder our COBOL is the choice of manufacturers like IBM, AT&T, DEC, HP and Wang.

Another breakthrough: Microsoft COBOL Tools.

Only Microsoft makes debugging this easy.

Our COBOL Tools is the perfect companion to our COBOL Compiler. A complete set of utilities. Tools that make debugging and maintenance easier than you'd thought possible.

The star of the show is ViewCOB, our advanced interactive debugger. ViewCOB lets you control and examine programs easily. Open windows on variables and procedures while watching the source code execute. ViewCOB is simply the most advanced COBOL debugger you can get.

Microsoft COBOL and COBOL Tools. An unbeatable team.

Microsoft COBOL Compiler Version 2.1 for MS-DOS and XENIX 286

Interactive extended screen section
- Cursor positioning, auto skip, and automatic data field formatting.
- ACCEPT or DISPLAY a screenful of data with a single statement.

Fast multi-key ISAM
- Split keys, alternate keys, duplicate keys.
- Benchmark results of 2500 reads, writes and rewrites to an ISAM file.

	Microsoft COBOL	Micro Focus native code	Ryand McFarland COBOL 2.0
Seconds	846	4073	1177

Source code compatible between MS-DOS and XENIX 286.

Microsoft COBOL Tools for MS-DOS and XENIX 286
- Cross reference utility speeds program development.
- Menu generator allows you to use Microsoft Word style menus in your program.
- Mouse interface allows you to create programs that use the mouse (MS-DOS only).

Advanced interactive debugger
- Use trace, single step, and execution history to follow the program flow.
- Observe the contents of variables and memory while the program is executing.
- Set breakpoints and change the contents of variables.
- Trap fatal runtime errors.
- Use the menu driven windowing user interface with on-line help.

Pascal

When you've outgrown the others.

Only Microsoft Pascal is powerful enough to push the outer limits of your PC. With more features than any other Pascal compiler.

Microsoft Pascal handles large programs with ease. No 64K boundaries —use multiple code and data segments up to a megabyte. Create your own libraries of pre-compiled Pascal modules. Separately-compiled modules can be overlayed or linked together into one file.

Our Pascal comes complete with the BCD and 8087 math libraries you'd expect. Including an IEEE floating point emulator. And Microsoft Pascal is completely compatible with IBM's Local Area Network and MS-DOS Networking. Added features without added costs.

Microsoft Pascal also supports direct interlanguage calling to modules written in Microsoft C, or Microsoft FORTRAN or assembly language. And it's compatible with our Macro Assembler's symbolic debugger. So you can track down those subtle logic errors with breakpoints instead of guesswork.

Microsoft Pascal. Nobody does it better.

Microsoft Pascal Compiler Version 3.3 for MS-DOS and XENIX 286

Microsoft Pascal Compiler
- Separate module compilation.
- Large program support; up to 1 megabyte code and multiple data segments.
- Overlay support.
- Contains four math libraries to choose from:
  - —8087/80287 coprocessor support.
  - —Fast IEEE floating point.
  - —8087/80287 floating point emulation.
  - —BCD decimal math.
- Link in your routines or third party software routines written in Microsoft FORTRAN (version 3.3 or higher), Microsoft C Compiler (version 3.0 or higher) or Microsoft Pascal (version 3.3 or higher), or Microsoft Macro Assembler.
- Source code compatible between MS-DOS and XENIX 286.
- Supports file sharing and record and file locking.
- Supports MS-DOS pathnames and input/output redirection.
- Do source level debugging with the Symbolic Debug Utility, available with the Microsoft Macro Assembler.

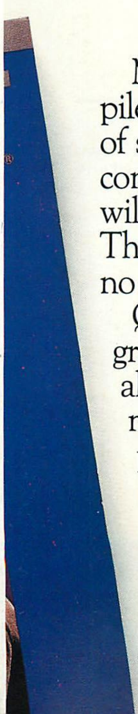
Library Manager
- Create, organize and maintain object module libraries created with Microsoft languages.

Object Code Linker
- Simple overlay linker combines relocatable object modules created using Microsoft languages into a single program.
- Link very large programs (over 1 megabyte) using overlays.

Microsoft EXE File Compression and File Header Utility (MS-DOS only)
- Compress, modify and examine executable files and their headers.

Microsoft QuickBASIC

BASIC just got faster.



Microsoft's new QuickBASIC Compiler gives your programs an extra burst of speed. Without sacrificing BASICA compatibility. Your compiled programs will run just like before, only faster. Three to ten times faster. With little or no modification.

QuickBASIC makes structured programming a snap. New extensions like alphanumeric labels make programming easier too. And separately compiled subprograms let you test and compile individual routines one at a time.

Microsoft QuickBASIC. All the features of a compiler, with BASICA compatibility to boot.

Microsoft QuickBASIC Compiler Version 1.0 for IBM PC and Compatible Computers

BASICA compatibility
- Sound statements including SOUND and PLAY.
- Graphics statements including WINDOW, VIEW, DRAW, GET, PUT, LINE, CIRCLE, LOCATE and SCREEN.

Results of the Sieve benchmark	BASICA	QuickBASIC
seconds per iteration	71	0.5

Structured programming support
- Subprograms can be called by name and passed parameters. Both local and global variables are supported.
- Multi-line functions can be called by name and return a value.
- BASICA structures are supported including WHILE/WEND, IF/THEN/ELSE, FOR/NEXT, GOSUB/RETURN, and event handling.

Alphanumeric labels
- Can be used to make your programs more readable. Line numbers are not required but are supported for BASICA compatibility.

Modular programming support
- Separate compilation allows you to create compiled BASIC libraries to use and reuse in your programs.
- Named common gives you control of data flow between individual modules.

Large program support
- Code can use up to available memory.
- Data can use up to 64K RAM.

LISP

The language of Artificial Intelligence.

What's Microsoft LISP got going for you? It runs significantly faster than the competition. And this new version adds several advanced libraries. Over 400 Common LISP functions, macros and special forms. Most implemented in machine code.

If you're putting AI on your PC, Microsoft LISP is your language.

muMATH

Mainframe math on your PC.

From solving equations to high precision calculations, muMATH is the ticket.

Microsoft muMATH handles tasks from algebra to calculus and vector analysis. Now your PC can do numeric analysis based on symbolic expressions. And give you exact answers.

If you crunch numbers—or equations—muMATH is just what the CPU ordered.

Sort

Versatility without compromise.

Microsoft Sort makes fast sorting easy.

A powerful, programmable interpreter lets you choose ASCII, EBCDIC or custom sequences. Sort handles files from any Microsoft language. Without limiting the size of your file, the number of search keys, or your record length.

Microsoft Sort. The speed and power you need. Easily.

The leadership edge.

No other languages are backed by as massive a collection of third-party software. Here are just a few of the companies that speak our languages: **Blaise Computing, Graphic Software Systems, Greenleaf Software, Inc., IMSL, Media Cybernetics, Microrim, Numerical Analyst Group, Phoenix Software, Solution Systems, Spruce Technology, Trio Systems, and Virtual Microsystems.**

This is just a sample. For a complete list, call Microsoft at the number below.

An added value for our readers.

We're proud of the way our family works together, so we're offering a $25 rebate on our Macro Assembler when you purchase Microsoft C, Pascal or FORTRAN.*

For more details, upgrade information or the name of your nearest Microsoft dealer, call toll free (800) 426-9400. In Washington State and Alaska, call (206) 828-8088. In Canada, (800) 387-6616.

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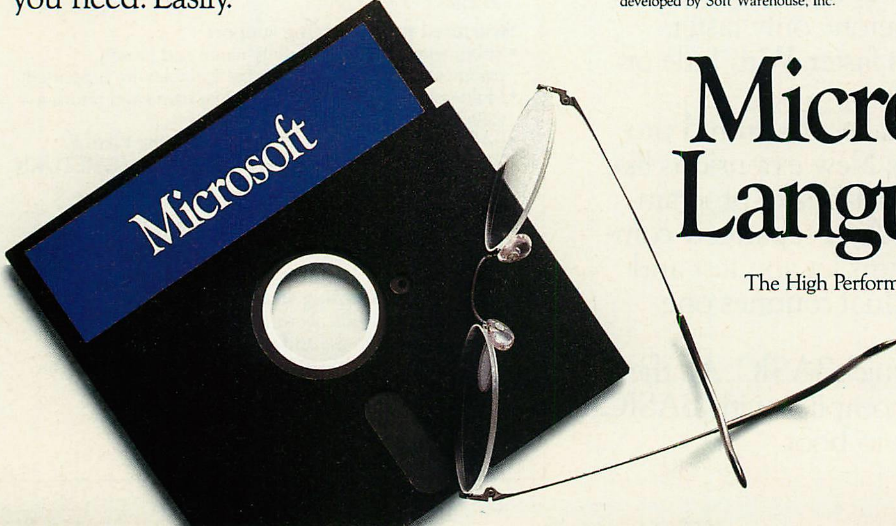
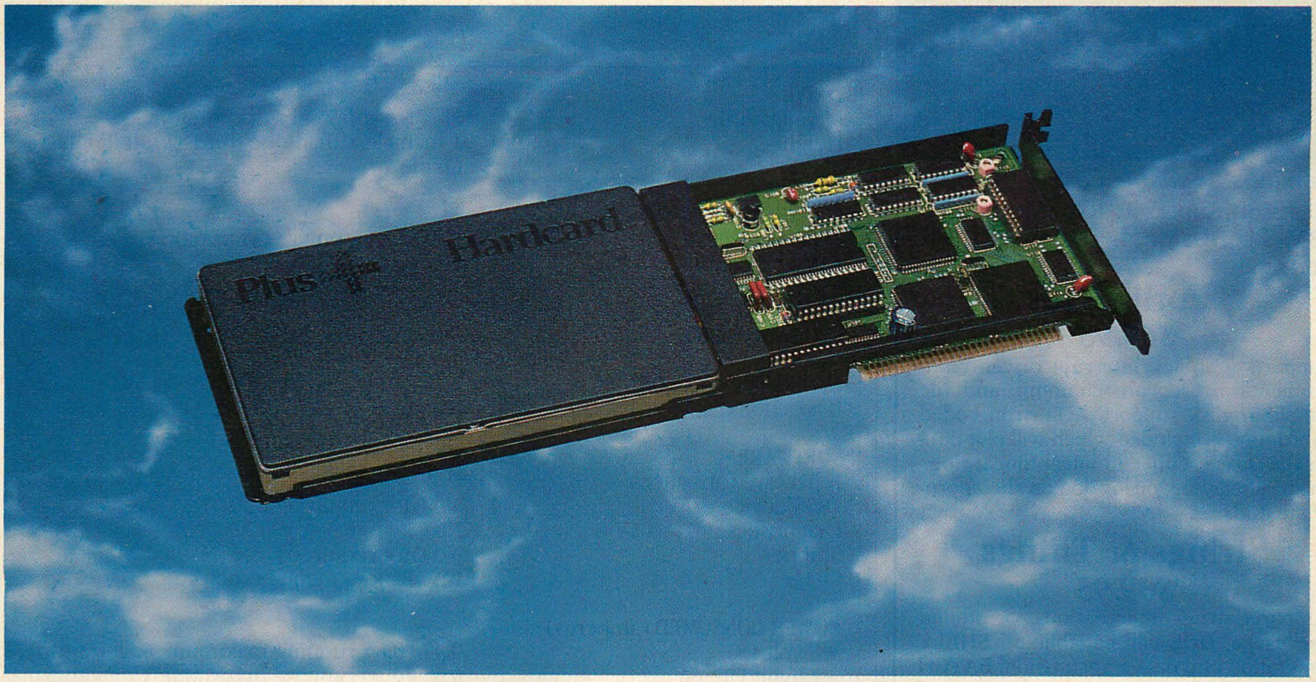


Microsoft® Languages

The High Performance Software™

0286 Part Number 098-400-201



The Hardcard, with its combination of a 10MB Winchester disk and controller on an expansion card, is fast, reliable, and easily installed by the user.

Storage on a Card

THOMAS V. HOFFMANN

Most users are accustomed to the idea of inexpensive hard-disk systems for the PC. *PC Tech Journal* reviewed ten internally mounted 10MB systems in November 1984 (see "Ten by Ten," Thomas V. Hoffmann, p. 52). Each system included a full-length adapter card and a 5¼-inch disk drive that mounted in a diskette slot on the system unit. Seven used half-height drives, three used full-height drives like those in the PC/XT.

The Hardcard from Plus Development Corporation integrates a 10MB 3½-inch Winchester disk and controller on a single expansion card. Installation involves just one screw that secures the card to the rear panel—no cables or connectors are needed. The drive is four inches high and only one inch thick, and the controller, which occupies about half of the card's length, uses high-density, surface-mounted custom LSI chips. Table 1 lists the Hardcard's technical specifications.

The disk and controller are newly designed by Plus. The disk contains a single platter that spins at the standard rate of 3,600 RPM; it has two read/write heads, one for each surface. The standard XT disk has two platters and four surfaces, each with 306 tracks of 17 sectors. The Hardcard has 612 tracks per surface, yielding the same 10MB capacity. Its fixed-disk BIOS presents a logical disk with 306 cylinders and four heads for compatibility with existing systems and applications. Table 2 shows the Hardcard space allocation under DOS.

The product claims a high degree of reliability, with an MTBF (mean time between failures) of 25,000 power-on hours. This is about double that for most other 10MB Winchester drives. In addition, the drive automatically retracts the heads to a safe landing zone when power is removed. This feature is helpful for a PC that is moved about because it averts the need to execute a special "shipper" or "head parking"

PHOTOGRAPHS • DAVID WAGNER

TABLE 1: *Hardcard Technical Specifications*

DRIVE	
Manufacturer	Plus Development Corporation
Height	1 inch (less than one-third of full height)
Media	Oxide
CONTROLLER	
Manufacturer	Plus Development Corporation
IBM-compatible	Yes
Extra functions	No
FIXED-DISK BIOS	On controller
INTERLEAVE FACTOR	3
User choice	No
SOFTWARE	
Hardware formatter	No
DOS device driver	No (not required)
Diagnostics	No
Shipper	No (not required)
Other	Installation, menu-based directory manager
POWER CONSUMED (amperes)	
+5-volt DC	0.47 (0.54 running maximum, 0.54 startup)
+12-volt DC	0.67 (0.70 running maximum, 1.27 startup)
AUXILIARY POWER	Not required
PERFORMANCE	
Capacity	10.56MB (minimum)
Transfer rate	5.00 MBits/second
Access times	15 ms track to track
(includes setting)	65 ms average
	105 ms full stroke

The Hardcard draws very little power and should not require auxiliary help, even in a standard PC that has a full complement of memory and adapters. The board's thinness permits other expansion boards to be placed in adjacent slots.

TABLE 2: *Hardcard Space Allocation under DOS*

ITEM (unit)	**QUANTITY**
Total cylinders used	305
Sectors per track	17
Sector size (bytes)	12
Logical surfaces (heads)	4
Total sectors	20,740
Hidden sectors (defect table)	17
Reserved sectors (boot, dir, FAT)	50
Available sectors	20,673
Cluster size (sectors)	8
Clusters	2,584
Wasted sectors	1
Total space available (bytes)	10,584,064

The Hardcard has two physical surfaces with 612 tracks each. The controller and BIOS make these appear as four logical surfaces with 306 tracks each. All but one are used; the last is reserved for diagnostic tests and is a safe landing zone.

program before each power down. The unit comes with a registration card for a one year warranty.

Plus's Hardcard fits in any full-length expansion slot in the IBM PC or XT, Compaq Portable or Plus, or AT&T PC 6300. It is thin enough to take only one slot, even in the narrow spacing of the XT, and not interfere with adjacent boards. Its physical installation is simple: turn off the PC, open it up, insert the card edge guide, put the Hardcard in the expansion slot, tighten the hold-down screw, and close up. The unit draws little power (0.54 amp maximum from the 5-volt DC supply, 0.67 amp maximum from the 12-volt DC supply) and should not require auxiliary help, even in a PC with a full complement of memory and adapters.

TABLE 3: *Benchmark Results for 10MB Disks*

	HARDCARD	PC/XT	AVERAGE[a]
SEQUENTIAL READ			
1 sector	19	22	20
8 sectors	48	71	50
16 sectors	77	126	86
24 sectors	110	187	125
RANDOM READ[b]			
1 sector			
0.10	52	70	73
0.33	75	120	113
0.50	85	160	143
0.90	102	240	212
8 sectors			
0.10	84	120	105
0.33	101	160	144
0.50	110	210	178
0.90	129	300	246
INTERLEAVE FACTOR	3	6	3

All times are in milliseconds per read.

[a]*These figures are the average of results for the DDS StoragePlus and the Qubie PC10, two 10MB internally-mounted 10MB systems. They were chosen for comparison because they each have an interleave factor of 3.*

[b]*Seek distance is the distance the heads travel as a fraction of the width of the disk platter.*

The controller has two sector buffers, which may give the system an advantage in multiple-sector sequential transfers. However, these results show the Hardcard is much faster in random seeks. Short, random accesses, such as database lookups, should display the system to its best advantage.

The installation manual does not mention any machines other than those listed above, but the card should work in any IBM PC compatible that can use a Zebec model 1410A disk controller (which the Hardcard emulates). The IBM Portable PC is an interesting example. It has only two full-length slots. The first, next to the built-in monitor, is shipped with the display adapter card inserted. Slot 2 is generally available, but it is very close to the brightness and contrast controls that protrude into the card cage area, and Hardcard simply will not go into it. For this review, Hardcard was installed by moving the display adapter to slot 2, then carefully forcing the Hardcard into slot 1. Great pressure and perseverance are necessary to get the drive portion past the metal support that keeps cards in slot 1 from touching the CRT housing, but the plastic covering on the drive protects against accidental shorts.

While this procedure cannot be recommended, it did work. The card sticks up a little in the back, but everything is tight and the unit reviewed survived several trips in the trunk of a car. The resulting system is about as full as any PC can be: 10MB fixed disk, two half-height diskette drives, 640KB memory, clock/calendar, parallel port, internal modem, and a second serial port.

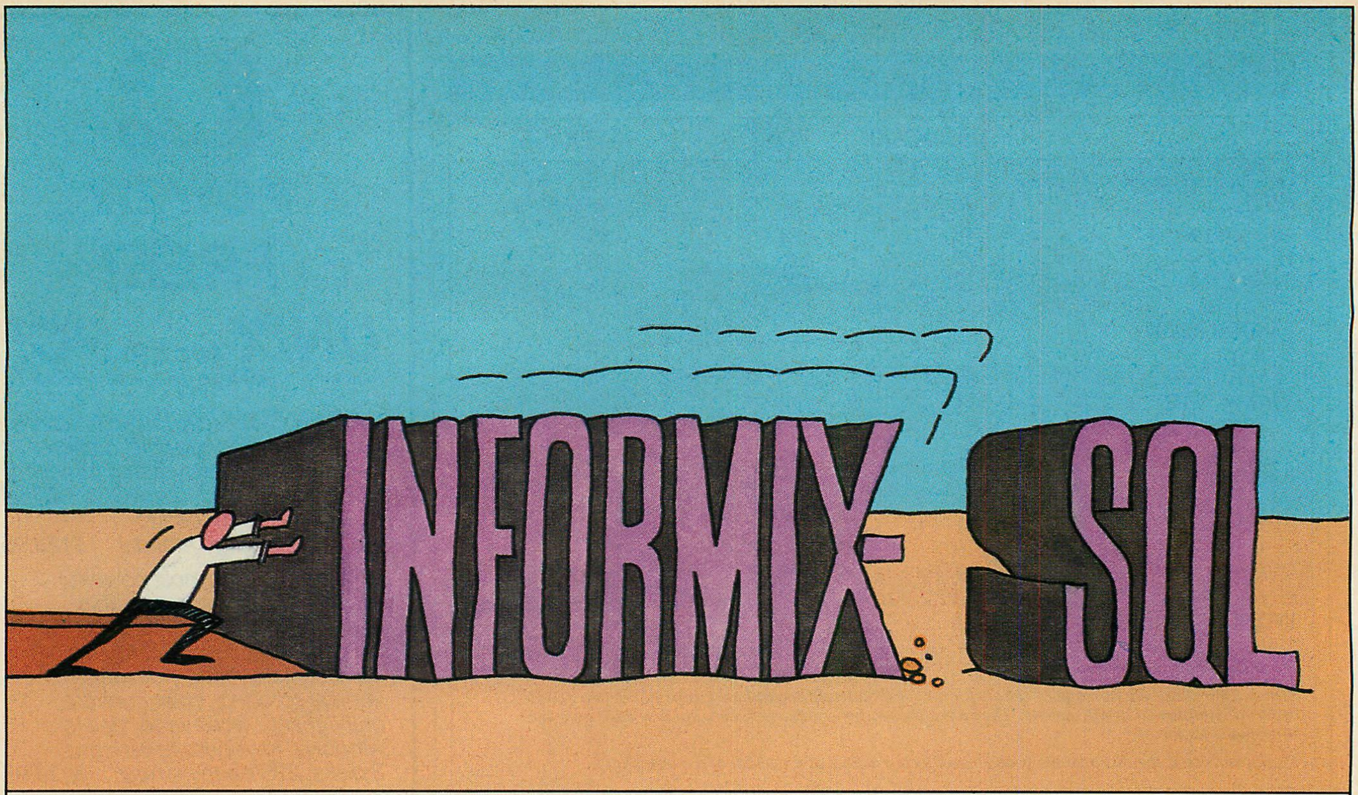
HARDCARD SOFTWARE

The Hardcard comes preformatted for DOS, and it has several programs already on disk. One of these is an automatic installation program that copies the files to a diskette (creating a backup for which a preprinted label is included), then formats the disk, partitions it, and installs DOS and other utilities from whatever system diskette the user supplies. Its reinstallation program repeats the procedure automatically from the backup diskette.

Because the Hardcard is hidden inside the PC, its activity is not indicated by a red light. Instead, two programs called SOUND and LIGHT provide optional audible or visible feedback when the Hardcard is accessed. SOUND ON causes a click from the PC's speaker and LIGHT ON displays a plus sign in the upper right corner. These features can be turned off if desired.

A menu-based shell program called HCD (Hardcard directory) lets the user set up 16 different applications to be invoked from a menu screen. A file called PROGHELP prints (on paper, not on the screen, with no option) instructions for installing many popular applications programs on the hard disk. The instructions are clear and useful.

Using any of this software is optional, although the manual does not



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emphasize this point. However, users who prefer not to use menus should be careful. During the review, the HCD was deleted for this reason (it was assumed that the data were backed up). Later, an attempt was made to load it back to check some information, but the backup disk had become unreadable. This was no one's fault, it simply happens sometimes. (It would have been safer to make two backups before deleting the files.) Plus Corporation sent a replacement diskette.

IMPORTANT FACTORS

The Hardcard has a very fast seek time, which accounts for its exceptional performance in *PC Tech Journal's* fixed-disk benchmarks (see "Fixed-disk Benchmarks," William J. Hunt, November 1984, p. 64); the results are shown in table 3. Its interleave factor of 3:1 also is a contributing factor (the XT is interleaved 6:1). Table 3 shows times for the Hardcard, the XT, and the average of the two 10MB systems reviewed in "Ten by Ten" that came formatted with 3:1 interleaving.

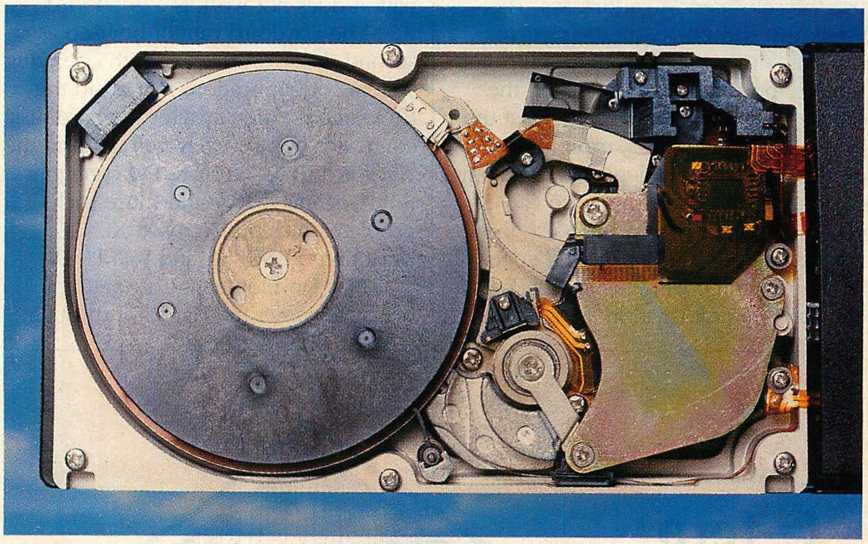
The benchmarks demonstrate that the Hardcard is marginally better in sequential transfers, but it is considerably faster for longer random seeks. The controller has two sector buffers that may give the system an advantage in multiple-sector sequential transfers. Its overall performance with a real application (loading Lotus spreadsheet files, for example) will not reflect exactly the same relative speed superiority because applications generally do some processing for each segment of a file that is loaded; speeding up the disk transfer impacts only part of the process. Short, random accesses, such as database look-ups, should help display the system to its best advantage.

The Hardcard comes formatted with a standard 17 sectors per track, but physically it has 18 on each. The extra one is used in case of a bad sector. The defect mapping and sector allocation is done during the hardware formatting process at the factory. No hardware formatter is shipped with the Hardcard. The formatter included with IBM's Advanced Diagnostics should *not* be used because it will overwrite the bad block table stored on the disk and defeat the spare block feature. (The space allocation for the Hardcard under DOS is shown in table 2.) To reformat the hardware to Plus Development's standard, the unit must be returned.

The Hardcard can be the only hard disk in a system or the second drive. Alone, it is recognized by DOS as drive C:. According to Plus, the controller is compatible with the IBM Fixed-Disk Adapter, and supports the IBM Diagnostics and Advanced Diagnostics.

If the Hardcard is used as a second hard disk, a jumper on the card that is normally in the PC position must be moved to the XT position. (All XTs already have a hard disk; many PCs do not.) This changes the hardware addresses of the controller's I/O registers from 320-323H to 324-327H, and moves its ROM fixed-disk BIOS from C8000H to CA000H. This allows the Hardcard to coexist on the same bus with another standard IBM controller.

PHOTO 1: *Internal View of Hardcard Hard Disk*



Above is a cutaway of the Hardcard. The head position is controlled by a pivot arm system located in the upper right area with the drive motor below.

Requests for drive D: are handled by the Hardcard BIOS, which knows to use the relocated I/O addresses. The BIOS also handles requests for drive C:—it assumes that the other controller is at the normal I/O addresses. If the other controller is not exactly what the Hardcard BIOS expects, trouble may ensue. Plus Development says that some third-party disk controllers can cause problems. Users who plan to use the Hardcard as D: with a non-IBM controller for C: should call Plus for the latest compatibility information. Even then, an ironclad agreement with the dealer to take one or the other back if the combination does not work is a good idea.

The Hardcard cannot be used as a second disk (as drive D:) with operating systems or applications that avoid the BIOS and go directly after the hard-disk controller because they will not find the Hardcard in its alternate I/O configuration. Systems that would cause such problems include Microsoft XENIX, Unisource VENIX/86, and IBM PC-IX.

Plus Development Corporation plans to market the Hardcard through retail computer dealers at a suggested price of $1,095. The company's market research indicates that most hardware sales to corporate users take place through the retail channel (though software is increasingly purchased by mail), and that 10MB disk upgrades were going for $1,000 to $1,500. The Hardcard is priced near the low end of that range and offers several advantages over the standard 5¼-inch Winchesters such as those reviewed in "Ten by Ten."

Its advantages include a simpler installation, faster operating speed, no need for auxiliary power, and no need to convert from full- to half-height diskette drives to make room for the new hardware. The theory is that people will be willing to pay the same or a bit more for a better product.

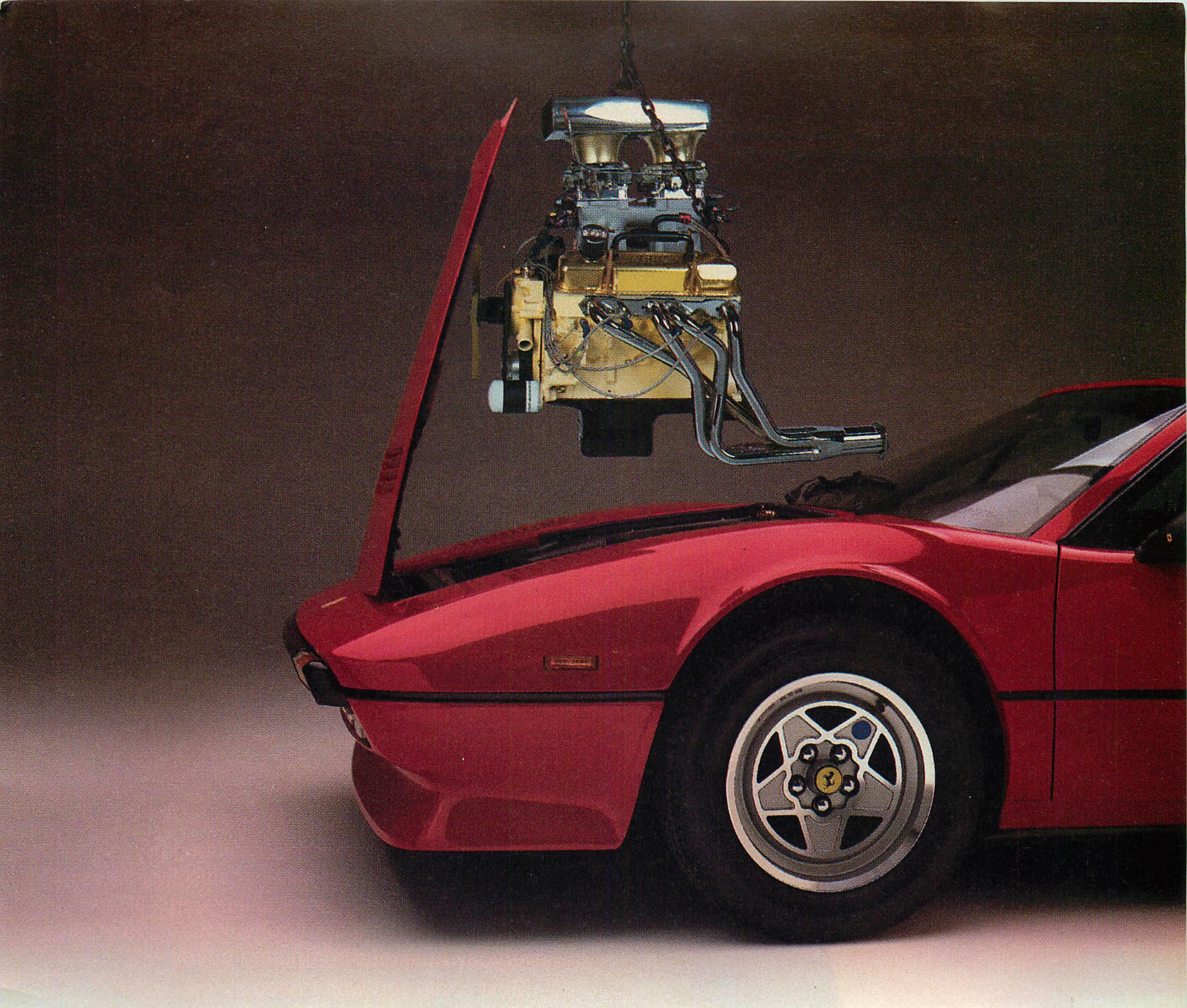
Some considerations come to mind. First, users may not be paying as much for 10MB disks as Plus assumes. Some mail-order houses advertise 10MB internal systems for as little as $395, complete with controller and mounting hardware. Retailers charge about $900, including installation. Large corporate purchasers probably get a slightly better deal. Further, *PC Tech Journal* surveys show that its readers *do* buy hard disks through the mail and apparently are satisfied with the results.

The Hardcard is ideally suited to mail-order sales. It is functional, reliable, and incredibly easy to install (unless it must be forced into a Portable PC—but that is not the fault of the Hardcard). Given that it does not require the user to buy a new power supply and that he does not have to throw out his old diskette drives to make room for it, the product is worth a premium. At $600 the Hardcard probably would be a runaway bestseller; as it is, an additional $500 is hard to justify.

The user will find much to like about the Hardcard, and it should be around for some time. It is technically and technologically sound, and an ideal add-on for any portable system. Plus should try to get the price in line with the rest of the disk market so it can be enjoyed by more users.

Hardcard: $1,095
Plus Development Corporation
1778 McCarthy Blvd.
Milpitas, CA 95035
408/946-3700
CIRCLE 318 ON READER SERVICE CARD

Thomas V. Hoffmann is director of advanced systems development for General Instrument Corporation in Hunt Valley, Maryland. He is consulting editor to this magazine.



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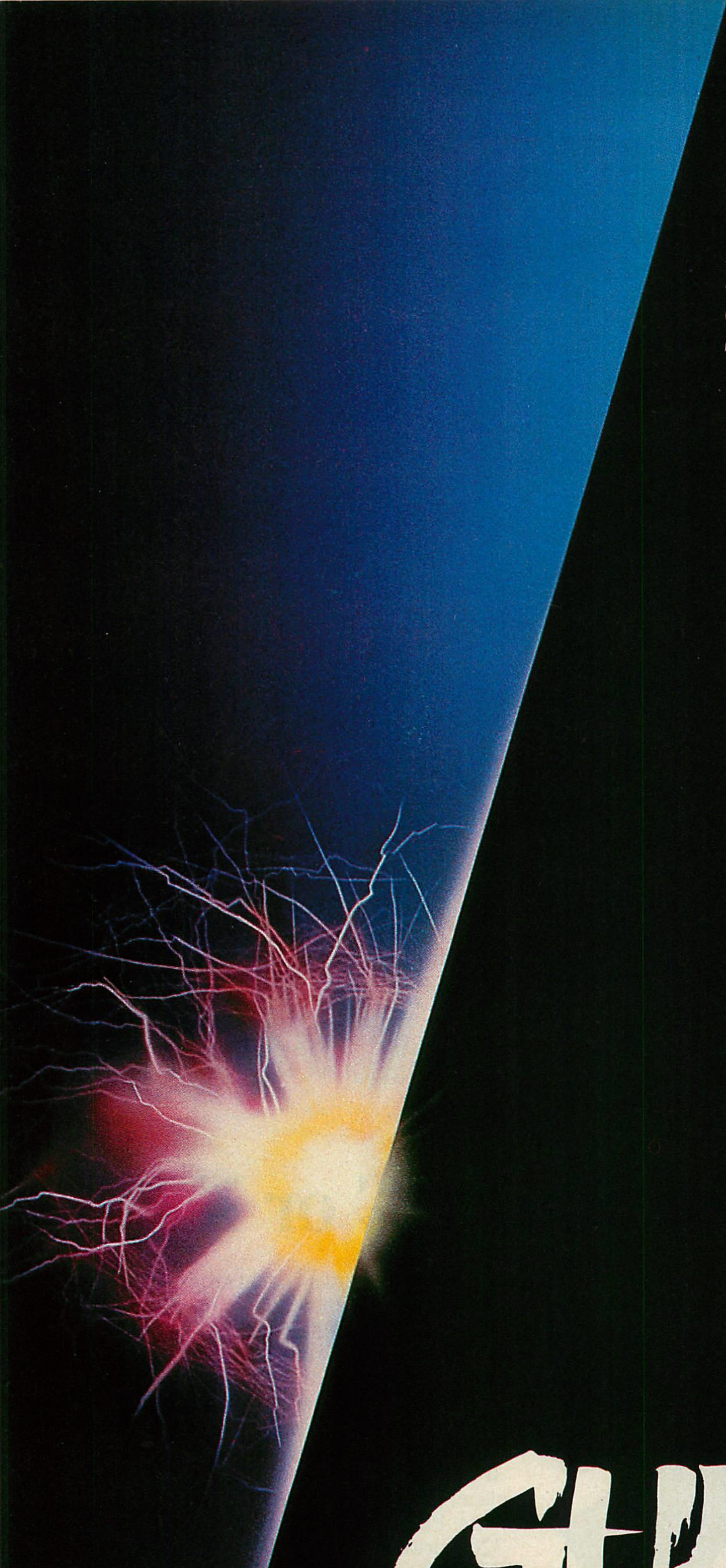

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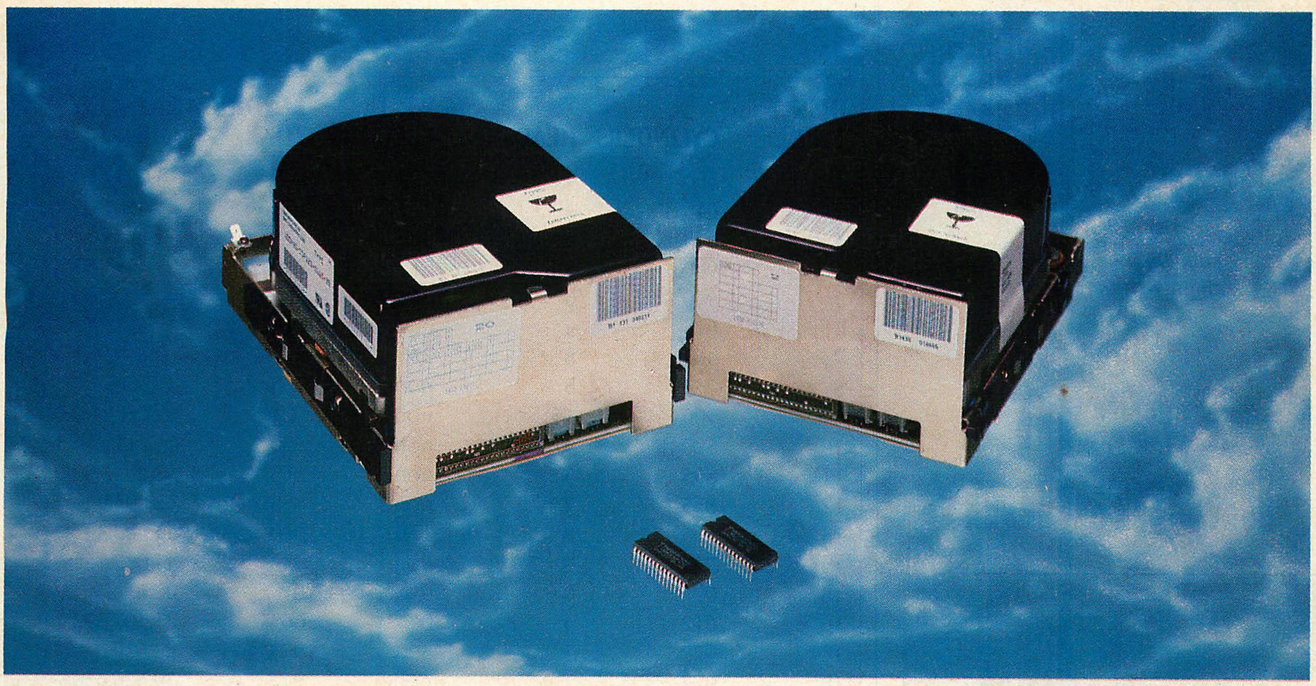


While it is not revolutionary, IBM's new fixed-disk drive for the PC/AT model 239 provides the user with an easy-to-install mass storage option.

Storage Expansion for the AT

THOMAS V. HOFFMANN

IBM's new 30MB fixed disk for the PC/AT is as noteworthy for the questions it provokes as it is for the answers it provides. The disk debuted with the model 239 AT, a system that offers not only this larger fixed disk, but also a new keyboard and ROM. The model 239 system board uses industry-standard 256KB dynamic RAM chips instead of the 128KB piggyback modules built from two 64KB chips that were used in the original AT. The new ROM supports the 14 standard types of fixed disks and the new 30MB drive, as well as several others (see table 1).

The 30MB disk is available as an upgrade kit that can be installed as either drive C: or drive D: in the original AT, or as drive D: in the model 239. Thus, it is now possible to have an all-IBM AT with 0-, 20-, 30-, 40-, 50-, or 60MB of fixed-disk storage built from various combinations of the two available disk capacities.

The list price for the model 239 AT is $5,995, only $200 more than that for the 20MB model 099. The 30MB upgrade kit is $1,795, again only $200 more than its 20MB counterpart. This $200 price difference should widen, however, because IBM will have been offering lower dealer prices on the 20MB model 099 ATs throughout the fourth quarter of 1985. A decrease in the consumer price of the model 099 should follow early in 1986.

Both the 20MB and the 30MB IBM disks have retractable heads that move to a safe landing zone when power is shut off. A *park* utility is not necessary.

PHOTOGRAPH • DAVID WAGNER

TABLE 1: *Disk Types Supported by AT BIOS*

DISK TYPE	CYLINDERS	HEADS	WRITE PRECOMP	LANDING ZONE	CAPACITY (MB)
1	306	4	128	305	10,653,696
2	615	4	300	615	21,411,840
3	615	6	300	615	32,117,760
4	940	8	512	940	65,454,080
5	940	6	512	940	49,090,560
6	615	4	none	615	21,411,840
7	462	8	256	511	32,169,984
8	733	5	none	733	31,900,160
9	900	15	none	901	117,504,000
10	820	3	none	820	21,411,840
11	855	5	none	855	37,209,600
12	855	7	none	855	52,093,440
13	306	8	128	319	21,307,392
14	733	7	none	733	44,660,224
15	0	0	0	0	0
16	612	4	0	663	21,307,392
17	977	5	300	977	42,519,040
18	977	7	none	977	59,526,656
19	1,024	7	512	1,023	62,390,272
20	733	5	300	732	31,900,160
21	733	7	300	732	44,660,224
22	733	5	300	733	31,900,160
23	306	4	0	336	10,653,696

The disk table in the ROM BIOS of the model 239 AT defines the hard disk types that are shown here. The new types are numbered from 16 through 23.

For testing, the 30MB upgrade kit was installed in a model 099 AT with a 20MB fixed disk and two diskette drives. The 30MB disk, a full-height drive, bore a striking resemblance to the 20MB drive already installed, which also was manufactured by IBM. IBM uses several sources for its PC components, and, as a result, the drives installed in a particular system actually may have been manufactured by some other company.

In addition to the drive, the upgrade kit contains a new set of ROM BIOS modules, a data cable to connect the drive to the fixed-disk adapter, a keeper bar that holds the drive in place, installation instructions, a diagnostic disk (version 2.0), and updated pages for the "Testing Your System" section of the *Guide to Operations.*

READY TO INSTALL

The installation instructions begin with a warning that the IBM limited warranty (which is good for one year, just as with the AT) applies only to properly installed options and recommend that the user allow IBM or an authorized dealer to install the system. Most customers probably would prefer that the dealer install the disk; the operation is not difficult, but oversights (such as forgetting to remove the terminating resistor pack from drive D:) are always a danger. However, the instructions are detailed and illustrated, and most users should find them quite helpful.

If a system's ROM BIOS is dated earlier than June 10, 1985, it must be replaced prior to installation of the new drive. However, the kit provided with the drive contains no tools for removing or inserting ROM modules.

Installing the disk itself is a straightforward operation that requires only a screwdriver and the proper cables. Because the 30MB drive is full height, the second diskette drive in the system used for testing had to be removed to make room for the installation of the new drive.

After eveything has been connected properly, the SETUP program on the diagnostic disk must be run to record the new system configuration. The instructions suggest using the SETUP program provided on the advanced diagnostic disk that comes with the *Hardware Maintenance and Service Manual.* However, for this review, the SETUP on the diagnostic disk included with the new drive was used because it is a more recent version.

TABLE 2: *Benchmark Results*

MACHINE	IBM 20MB FIXED DISK	IBM 30MB FIXED DISK	IBM PC/XT FIXED DISK
SEQUENTIAL READ			
1 sector	4	4	22
8 sectors	26	26	71
16 sectors	51	49	126
24 sectors	77	76	187
RANDOM READ			
1 sector			
0.10[a]	36	34	70
0.33	43	51	120
0.50	57	60	160
0.90	66	59	240
8 sectors			
0.10	58	63	120
0.33	66	71	160
0.50	77	81	210
0.90	90	80	300
INTERLEAVE FACTOR	2	2	6

[a]*Results for IBM 20MB and 30MB fixed disks were obtained on a 6 mHz PC/AT.*

Benchmark results for the 20MB and the 30MB hard disk drives are shown here in comparison with those for the PC/XT hard disk. The 30MB disk performed well.

The label on the front of the disk drive showed eight bad spots (the 20MB disk used for testing had no bad spots) and a type code of 20. The old SETUP program allowed type codes only from 1 through 15; the new one prompted for codes from 1 through 47. After SETUP, FDISK and FORMAT were run (which took 4 minutes, 15 seconds) and the system was ready.

A 30MB disk has a capacity of at least 30,000,000 bytes, usually more. The type 20 disk has 733 cylinders and 5 heads. Each track of 512 bytes is formatted with 17 sectors; thus, the maximum number of bytes available is 31,900,160. The amount of usable space, which does not include boot blocks, bad track tables, the root directory, FATs, and other overhead, is 31,768,576 bytes, minus the bytes that are in the eight bad spots on the test disk.

The 30MB disk drive performed well in the *PC Tech Journal* disk-drive benchmarks (see "Fixed-Disk Benchmarks," William J. Hunt, November 1984, p. 64); it produced times that were slightly faster than those for the 20MB drive. (See table 2.)

NEW ROM VERSUS OLD

When IBM introduces a new ROM BIOS for a member of the PC family, questions arise: Why now? What has been changed? What bugs have been fixed? What hidden features have been added? IBM's listings, which usually help to provide the answers to some of these questions, have not yet been published for this new ROM. However, some information is available.

The ROM in the AT provides 64KB of memory, 32KB of which is used to contain the Cassette BASIC interpreter. Both the old and the new AT ROMs use BASIC version C1.10—no change there.

The uppermost 8KB of the AT ROM BIOS, from F000:E000 to F000:FFFF, is made up primarily of error message text, tables, and entry points that provide compatibility with the original PC ROM. The number of existing programs that presume the locations of various ROM routines and interrupt service routines has prompted IBM to preserve those entry points, if only to serve as jumps to new locations where the work actually is performed.

Differences between the top 8KB of the old and the new ROMs indicate that the new version is the product of source changes, not simply a few patches. For example, the text of the error messages has been rearranged and is now stored in order by error code number. Many jump tables and interrupt vector tables point to routines in the lower 24KB that have been moved to new locations. Some routines have been changed slightly, some have been reordered. The ASCII-encoded identification numbers, the copyright notice, and the date code have been updated (the new date code is 6/10/85).

The only functional difference announced by IBM is the support for the

new 30MB disk drive. The original ROM BIOS supported four nominal 30MB drives (see table 1), but none of these has the same parameters as the type 20 drive in the upgrade kit (although type 8 differs only in its write precompensation value). The original ROM defined disk types 1 through 14 and reserved type 15. The ROM can support a total of 47 disk types. Version 2.0 of the diagnostic disk accepts disk types 1 through 47; the new ROM defines only types 1 through 23 (as with the original ROM, type 15 is reserved).

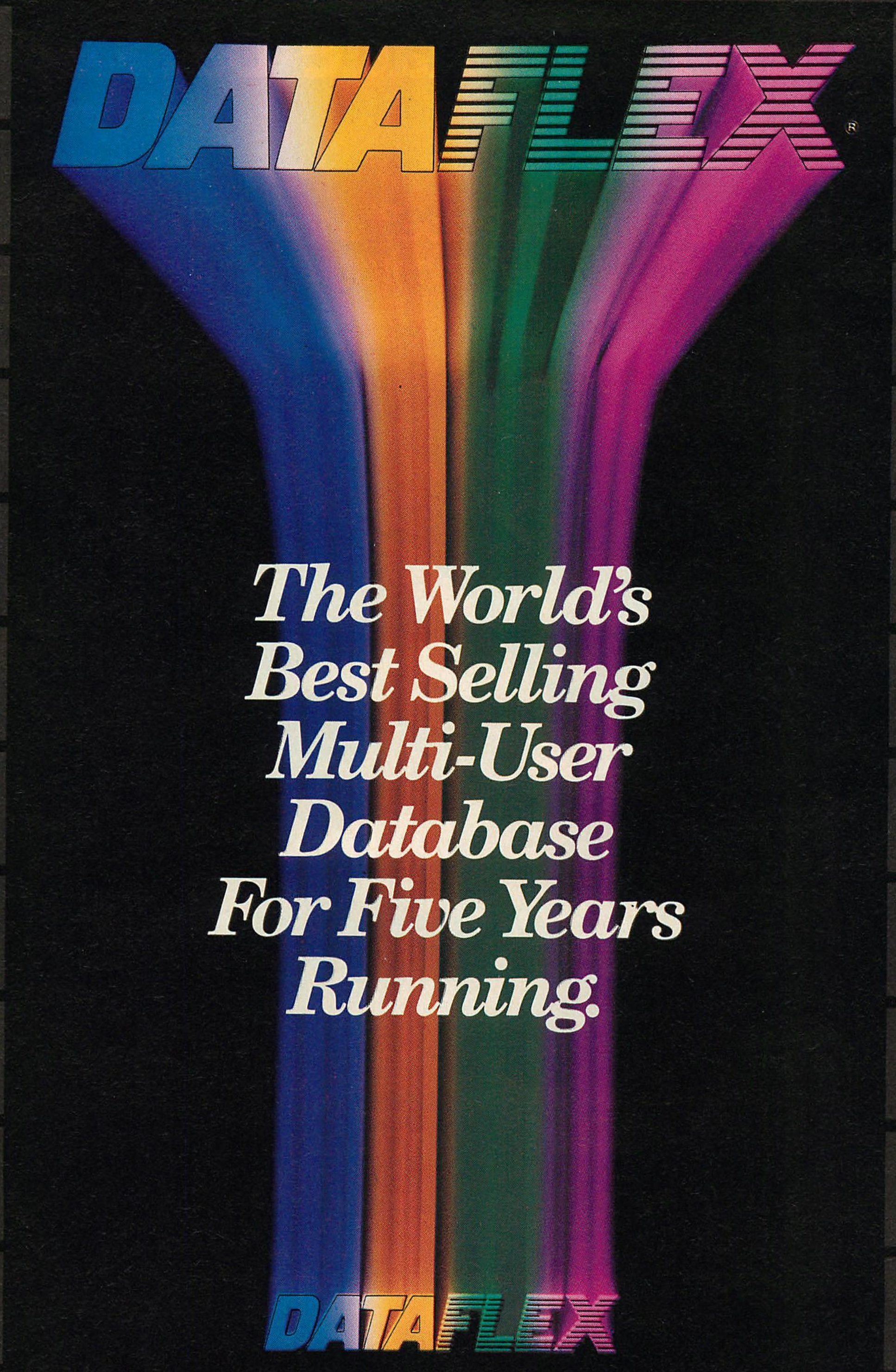
Because the new ROM supports more than 15 fixed-disk types, changes in the configuration set-up code are required. The original ROM used only four bits to store a type code; it packed the types for drives C: and D: into a single byte. Other routines show signs of minor improvement, also. The timer interrupt routine now disables interrupts before it issues the EOI (end of interrupt) command to the 8259A interrupt controller; the original version left interrupts enabled. The print screen routine (software interrupt 5) sends a carriage return followed by a line feed to the printer after each line of text; the old version sent the line feed first, followed by a carriage return.

Of greater concern, particularly to those who have replaced the original crystals in their ATs with faster ones to boost performance, is the news that the new ROM fixes the clock speed at 6 mHz. The IBM technical documentation states, "Note: Installation of the 30MB Fixed Disk Upgrade Kit will fix the microprocessor clock speed at 6 mHz." This indicates some code in the new ROM will not work at speeds greater than 6 mHz, possibly a side effect of a change to improve the reliability of some device control code (such as adding a software time-out).

The new 30MB fixed disk and model 239 AT are not revolutionary. They are, however, small improvements to IBM's PC family that give users increased versatility.

239 AT: $5,995
30MB upgrade kit: $1,795
IBM Corporation
5201 S. Congress Avenue
Boca Raton, FL 33432
Contact the local IBM dealer;
800/426-2468
CIRCLE 356 ON READER SERVICE CARD

Thomas V. Hoffmann is the director of advanced systems development for General Instrument Corporation. He is consulting editor for this magazine.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VENIX: Setting UNIX Standards

AUGIE HANSEN

AT&T's System V specification begins to establish a standard UNIX base; VENIX brings the new standard to the PC.

VenturCom has brought to market the first UNIX System-V compatible operating system that runs on the PC/XT and PC/AT. VENIX is a port of AT&T sources to the PC family and to several other microcomputer and minicomputer products. Along the way, some features have been added to permit access to DOS programs and data files; a sprinkling of specialty programs has been included as well. Other System V release 2 products from the Santa Cruz Operation and IBM (via Microsoft and Interactive Systems) have been announced or will be shortly.

So why all the interest in System V? Mostly this is a matter of setting standards to avert long-term disarray in the UNIX community. Viewed from a distance, UNIX has taken on a Hydra-like appearance because of efforts by third parties and AT&T itself to make UNIX do things its designers never intended.

Offshoots of the seventh edition (called version 7), with many Berkeley extensions, are hot in scientific and CAD/CAM circles because of additions made in graphics support, among other things. Other UNIX vendors have added helpful realtime features, usually at the expense of multitasking performance. Still others have emphasized modifications to the file system to facilitate database applications. (See "Reflections of UNIX," Augie Hansen, *PC Tech Journal*, May, 1985, p. 54, for an overview of several PC UNIX systems.)

The AT&T System V Interface Definition (which is discussed in the sidebar that accompanies this article) is the intended rallying point for present and future UNIX systems development. Already Sun Microsystems and Microsoft have entered into agreements with AT&T regarding the convergence of their respective systems into one that is

common at the core. However, some differences among operating system and application extensions are welcome and to be expected, in order to distinguish various products and to accommodate real market demands for specialized features and functions.

AT&T's 3B2 supermicrocomputer and 7300 UNIX PC are substantially impacting the perception of System V as a standard for UNIX, VENIX, XENIX, and other systems based on UNIX. The promise of source code compatibility across a wide range of machines is an important consideration to a company preparing an applications product for market. Because these machines run AT&T's System V release 2 operating system, it is possible to recompile the programs without changing the source code. Of course, if a program depends on nonstandard extensions, such as bit-mapped display features and the user agent, then porting will require additional work to revise the interface.

Object code compatibility across machines that use compatible processors, such as those in the Intel family, is an added bonus. The System V standard specifies source code compatibility, but it took some ingenuity to achieve object code compatibility. To illustrate, a program written and compiled on a VENIX/86 system (PC/XT) can be moved unchanged to a VENIX/286 engine (PC/AT) and run in protected mode—no need to recompile or patch. A defective program that could render an XT useless will cause only a memory protection violation and a debugging core dump when run on the AT.

VENIX is available for two broad classes of machines: the Intel microprocessors (8086/88, 80186/88, 80286) used in the IBM PC, XT, AT, and many compatibles, and the DEC processors used in the Pro 350/380, PDP-11-series, and LSI-11 computers.

The VENIX System V product is large (because System V is large). The PC versions consume approximately 9MB of disk storage if all of the operating system features and optional programs are installed. On a PC or XT equipped with a 10MB hard disk, this leaves little room for user applications and data files. A system administrator may reserve more disk space for users by eliminating unnecessary files. VenturCom offers guidance regarding disk space conservation in the notes that accompany release 2.

The company recommends a minimum of 256KB RAM and 10MB on a hard disk, but systems with more than one user will require at least 512KB of main memory and 20MB on the hard disk to accommodate any serious work.

TABLE 1: *Upgrading 2.0*

CHANGED COMMANDS
cu
echo
login
ls
nroff
ps
stty
sum
(ratfor compiler is omitted)
CHANGED SYSTEM CALLS
access
alarm
ioctl
signal
(sema mechanism has been dropped in favor of "counting")
CHANGED SUBROUTINES [a]
curses
fopen
printf
realloc
string

[a] *In the C language and standard I/O libraries.*

VENIX 2.0 programs will run under VENIX System V release 2 without major revisions. However, some version 2.0 commands behave differently under System V. These upward compatibility snags are listed above.

The VENIX documentation is complete and well written. Much of it is reproduced from the original AT&T distribution, although some portions, especially those that are related to system administration, were rewritten or heavily revised by the VenturCom staff. Four very full 6½-inch-by-9-inch ring binders hold the information, most of which has been typeset.

The software is distributed on a set of 21 diskettes. One contains the transfer programs that begin the installation process; diskettes A through F hold the system files; and diskettes 1 through 13 contain the user files. One floppy disk contains machine-dependent programs. Except for the last, the diskettes are identical for the XT and AT installations. It takes about an hour to prepare the hard disk and to install the entire VENIX system on an AT. A much slower disk on an XT-compatible machine can add 10 to 15 minutes to that time.

Owners of older VENIX versions should note that mountable file systems and **dump**-format diskettes are not transportable between old versions and VENIX System V. VenturCom recommends saving source and data files using **tar** before installing the new system. Table 1 is a summary of command changes from VENIX version 2.0 to VENIX System V release 2 that could cause upward compatibility problems. System V enhancements that pose no such problems are listed in table 2. The changes include enhancements to commands, many entirely new commands and function calls, and enhancements to system calls and device drivers.

The VENIX quadscreen feature uses display memory buffers on the color graphics adapter. The feature is not available on monochrome-only systems, however, because monochrome adapters provide no additional memory for paging. This approach differs from the multiscreen virtual console feature of SCO's XENIX, which uses buffers in main memory for each virtual console. Although the latter method consumes 4KB per console, it makes the feature available on any display system.

CONNECTIONS

VENIX provides a means of exchanging data with DOS, but the interface is only marginally useful. Table 3 lists and describes the DOS interface commands. This add-on capability is not well designed (from the user's perspective), nor has it been fully debugged. However, VenturCom has been responsive to problems reported during this review and some of the bugs that were discovered have been fixed.

One problem with the DOS interface is that it is cumbersome. Except in rare cases, the user must indicate DOS files to VENIX by prefixing path names with **dos!** and VENIX path names by prefixing specified paths with **venix!**. This seems unnecessary because in most situations the command context renders this information redundant. The respective DOS interfaces of PC/IX and XENIX are superior overall.

The DOS interface also has problems performing file copies that use wild-card specifications. A bug in the interface involving diskette volume labels and recursion along a directory path name has been fixed, but VENIX still has problems copying a set of files out of a subdirectory on a floppy disk.

The **uucp** (UNIX-to-UNIX copy) and **cu** (call UNIX) programs provide the primary connections to other computer systems and networks. The **setline**, **modem**, and **ttystate** commands are used to allocate, enable and disable,

TABLE 2: *VENIX System V Enhancements*

NEW COMMANDS	id	pcat, unpack
asa	ipcrm	red (ed)
batch (at)	ipcs	regcmp
cflow	killall	rsh (sh)
cpio	labelit (volcopy)	SCCS[a]
crontab	line	setline
csplit	logname	tic
ctags	mkstr	tput
ctrace	mm	ttysate
cut	mmchek	uname
cxref	modem	volcopy
dirname (basename)	newform	whodo
env	news	xargs
fsplit	nl	xstr
getopt	pack	
head		
COMMAND ENHANCEMENTS		
The following commands have new or changed options and added features:		
cat	lint	sort
cc	lp	vi
cu	pr	who
ld	sh	
NEW SYSTEM CALLS		
In addition to named pipes (FIFOs), VENIX adds the following:		
fnctl	msgget	uname
getpgrp (getpid)	msgop	ustat
lockf	setpgrp	
msgctl	ulimit	
SYSTEM CALL ENHANCEMENTS		
These calls now conform with the System V interface definition:		
chown		
signal		
DRIVER ENHANCEMENTS		
• Improved bad-track remapping for hard disks		
• ANSI control sequences for the console drivers		
• OS kernel reconfiguration is permitted using config		

[a] *SCCS is the source control system composed of the following commands:*

admin	get	sccsdiff
cdc	help	unget
comb	rmdel	val
delta	sact	what

These System V enhancements cause no upward compatibility problems.

and initialize PC ports for **uucp/cu** usage. The programs worked fine for setting up and running dial-out connections. An external Hayes-compatible modem worked correctly with no modification of the **/usr/lib/uucp/L-modems** modem definition file entry.

Additional ports may be used, such as those provided on quad-port and eight-port boards. The maximum number of licensed users specified in the purchase agreement is enforced in the software; the enforcement algorithm allows for the use of dial-in and dial-out ports for machine-to-machine communications, which do not count against the licensed user limit.

PERFORMANCE

VENIX is a good performer in the compiler benchmarks (see table 4). The AT system used had a 20MB hard disk (37-millisecond average access time) and 1.64MB of RAM. The XT system had a 10MB hard disk (85-millisecond average access time) and 576KB of memory. VENIX recognizes the presence of the additional RAM and uses it effectively. These simple tests highlight some important aspects of operating system performance. (Note that these results can be compared with those for XENIX in "XENIX for the XT," Augie Hansen, June 1985, p. 129 and for PC/IX in "PC/IX," Augie Hansen, July 1985, p. 80.)

Because VENIX apparently uses identical names for temporary files in the **/tmp** directory during compiles, it had problems with the multitasking tests. When one compile job clears its temporary files, it also deletes those of other compiles spawned by the same parent shell, making it impossible to run concurrent background or foreground/background compiles. Dissimilar jobs running concurrently (background printing or compile with foreground editing, for example) do not interfere with each other in this way.

VENIX's implementation of the **vi** editor contains a few bugs that VenturCom is working to eliminate: a time-out problem on the Esc key used to terminate insert-mode operation, and a lock-up condition when **showmatch** is set and a matching opening brace, parenthesis, or bracket is highlighted. However, the editor loads quickly and seemed well behaved in all other respects. Further, unlike the editors with other UNIX-based systems, this **vi** editor implements auxiliary keypad arrows and PgUp/PgDn keys.

TABLE 3: *DOS Interface Commands*

COMMAND NAME	DESCRIPTION
dos	Invoke a DOS shell. Prompts with **dos:** and accepts the commands shown below. ^C (the equivalent of BREAK) returns control to the VENIX shell.
dosdel	Delete named files from the DOS diskette.
dosdir	Displays information about files and directories on the DOS diskette.
doscopy	Copies files between DOS diskettes and the VENIX file systems. The **−a** option is required to correctly handle ASCII files that require conversion of the DOS CR/NL pair to the VENIX NL convention and the reverse.
dosren	Rename a DOS file.
dostype	Display the contents of a DOS file or a list of files. This command does not support I/O redirection.

The VENIX/DOS interface is not well designed, nor has it been fully debugged. Except in rare cases, the user must indicate DOS files to VENIX by prefixing path names with dos! and VENIX path names by prefixing specified paths with venix!.

SYSTEM DIFFERENCES

The VENIX designers tried to follow the interface definition of UNIX System V; they succeeded in all but three areas. These intentional departures from the standard should be noted:

- First, the alarm functions, **sleep()** and **alarm()**, use unsigned arguments in System V release 2, but are signed under VENIX to permit the use of negative numbers to specify clock-tick durations. This permits finer grained alarm and sleep settings (to one-sixtieth of a second) than the whole seconds of the UNIX specification, and is useful in realtime applications. VENIX supports realtime via the **nice** command, which allows only the super user (root) to specify negative increments to obtain higher priorities for some processes.
- Second, VENIX does not accept the use of control characters in path names. Instead, it replaces each such character it encounters with a sharp sign (#). Because using control characters in file and directory names is usually accidental (and a poor practice if done intentionally), this is probably a good idea.
- Third, in the area of shared memory, VENIX uses what VenturCom calls a "functionally superior" method. Primarily, this method permits a compatible interface to share memory across Intel and DEC architectures, but it is not source-code compatible with the System V release 2 interface definition. The superiority of this method lies in its ability to access shared data segments that exceed the allotted 64KB address space.

AT&T's **curses** and **terminfo** are the heart of the virtual terminal interface used by VENIX. This version of **curses**, originally developed at the University of California at Berkeley has been rewritten by AT&T to work with a greater range of terminals and capabilities and to use a compiled terminal database for greater speed of loading and execution.

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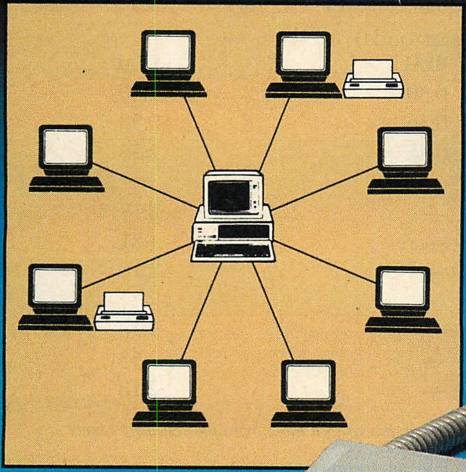

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TABLE 4: *Performance Summary*

C COMPILER[a]	PC/AT			PC/XT		
Program size (bytes)	**SOURCE**	**OBJECT**[b]	**EXECUT.**	**SOURCE**	**OBJECT**[b]	**EXECUT.**
empty	11	60	116	11	60	116
sieve	663	314	212	663	314	212
hello	77	133	8,616	77	133	8,490[c]
Compile time (seconds)	**REAL**			**REAL**		
empty	0:05	—	—	0:21	—	—
sieve	0:07	—	—	0:30	—	—
hello	0:09	—	—	0:30	—	—
Timings (seconds)	**REAL**	**USER**	**SYSTEM**	**REAL**	**USER**	**SYSTEM**
empty	0.1	0.0	0.0	0.3	0.0	0.1
sieve	2.3	2.3	0.0	6.9	6.6	0.1
hello	0.1	0.0	0.1	0.3	0.0	0.3
MULTIPROCESSING TESTS (minutes:seconds)						
Foreground sequential		**REAL**			**REAL**	
make sortdemo		0:30			1:30	
make xsort		0:16			0:58	
Total time		0:46			2:28	
Background/foreground[c]						
(make sortdemo; echo "\07 1") &		—			2:18	
make xsort		—			1:51	
Total time		—			2:18	
Background simultaneous[c]						
(make sortdemo; echo "\07 1") &		—			2:18	
(make xsort; echo "\07 2") &		—			1:53	
Total time		—			2:18	

[a] *Programs were compiled with the −s option to strip the symbol table from the resulting object and the −O option to produce optimized code.*

[b] *The* **cc** *command removes the .o file after the link step is completed so the size of .o files was obtained separately using the command line* **cc −O −s −c file.c** *after the full compile job was run using* **cc −O −s −o file file.c**.

[c] *The simultaneous tasks could not complete on the AT because of an apparent problem with the naming of temporary files. This problem has been fixed as can be seen in the results for the XT version of VENIX, which is a more recent release of the product.*

The Venix system performance tests were conducted with a user logged onto the console as root and another user logged on via a direct serial connection.

For downward compatibility with programs that make calls to the old **curses** support package, VENIX retains the older library routines and the **termcap** database. A special library called **libbcurses** is linked to programs of the older vintage with this command:

cc [options] [files] − **lbcurses**

The source files should include the header file **<bcurses.h>**.

VENIX System V is a full-featured package that offers fast operation. Presently it is flawed by several minor bugs and a few major ones. However, VenturCom's track record of support for earlier VENIX versions gives encouragement that these bugs will be found and fixed. Updates will be made available to licensed owners as the improvements are made; the prices for updates have not been established.

The DOS interface is the area most in need of significant improvement in this system. A developer of custom applications, for example, depends on a flexible and reliable connection between UNIX and DOS. The VENIX/DOS interface is neither flexible, nor reliable at this point. Nevertheless, this is a complete package that, when the bugs are fixed, will be a good value in a multiuser, multitasking operating system for IBM XT and AT class machines. In the meantime, this is a positive step toward a common UNIX.

VENIX 2.0: $1,195
VenturCom, Inc.
215 First Street
Cambridge, MA 02142
617/661-1230
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CONSIDER IT STANDARD

This is how AT&T would like everyone to think about System V. It is also the wish of numerous others in the UNIX community who recognize that the long-term viability of this operating system is seriously threatened by the proliferation of specialized versions. One predominant flavor of UNIX most likely will never rise to the top of the heap and match the extensive market penetration of single-user MS-DOS/PC-DOS. However, considering the many users of multiuser UNIX, not just the number of licensed sites, a standard UNIX could, over time, build a very large user population.

The standards committee of /usr/group, an independent organization, has worked for years to define a standard UNIX operating system. AT&T has included many, but not all, of the organization's recommendations in the *System V Interface Definition*, a document that specifies at several levels "...an operating environment where applications software can be written that is independent of any particular computer hardware." Already UNIX is running in various forms on everything from microcomputers to the latest Cray supercomputers—this range of environments is unmatched by any other operating system. AT&T also has taken into account recommendations of the proposed ANSI standard for the C language and standard libraries. Some of the ANSI and /usr/group proposals are in conflict. AT&T has some tough choices to make.

In defining System V, AT&T specified components made available to applications programs and to users, but did not specify implementations. The system interface is defined in terms of a base requirement plus optional extensions. If extensions are available in a given implementation, they must conform to the specification. In addition, vendors of System V-compatible systems are free to add their own extensions as long as the validity of items covered by the definition is maintained.

The substance of the interface definition is organized as shown in the table that accompanies this sidebar. Vendors who wish to have their System V products verified (tested for conformance with the interface definition) must pass the UNIX regression test suite (URTS). Several vendors, including VenturCom, are using prerelease copies of URTS to fine tune their System Vs. They plan to submit the software to AT&T for formal verification when the test suite is officially released.

TABLE: *System V Levels*

BASE
Operating system services
Error conditions
Signals
Other library routines
Header files
Utilities
Environmental variables
System-resident data files
Directory tree structure
Special device files
K_EXT
Kernel extensions
EXT (extensions for:)
Basic utilities
Advanced utilities
Software development
Network services
Large machine
Graphics
Basic text processing
User interface services
Database manager

The evolution of the UNIX standard will be controlled by *commitment levels* assigned to each component of the definition. These commitment levels indicate the degree of permanency of the specific component.

UniSoft, a Berkeley, California company that has done numerous UNIX ports, has been tapped by AT&T to provide the verification suite that will be used to test vendors' systems for conformance to the new standard. VenturCom, the Santa Cruz Operation, and Microsoft are among the guinea pigs who have agreed to help debug the test set.

Both the United States government and IBM have effectively endorsed UNIX System V as the multiuser operating system of choice for many applications. The Pentagon insists that computer system vendors offer UNIX software before they will be considered in its bidding process. IBM is looking out for its own interest, a large part of which involves giving its customers what they want. Many of them want, even demand, UNIX. Other large computer companies, Amdahl and Cray for example, have announced plans to go the System V route as well.

IBM is now committed to moving its UNIX OS software to the System V standard—a shift that would involve everything from PC/IX on the PC/XT to VM/IX, a mainframe version of UNIX that runs as a guest OS under IBM's virtual machine (VM) OS. IBM would, of course, prefer to sell its own systems and not plug the competition, but it apparently sees UNIX as a path to moving a lot of equipment in the future.

The *System V Interface Definition* is a living document that will require modifications over time in order to track continuing evolution of the system as AT&T UNIX is merged with features from XENIX, Berkeley UNIX, and other branches of the family tree. AT&T will try to keep any one edition of the standard in effect for a reasonable period of time so that most vendors will be inclined to get in step with the rest of the industry rather than to set their own cadences. Those who would "walk to the beat of a different drum" will do so at their own peril given the apparent overall gravitation to the new standard.

The evolution of the standard will be controlled by *commitment levels* that are assigned to each component of the definition. A component tagged as a level 1 commitment will remain in the definition and be migrated into future editions in an upwardly compatible way. Items given a level 2 commitment initially and those moved to level 2 from level 1 will remain in the definition for a period of no less than three years, after which they may be dropped from the definition. Also, components of extensions may migrate into the base system definition (the converse is not true) and new extensions may be added in future editions of the definition.

—AH

System V Interface Definition: $27
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DATA MANAGERS AS DEVELOPMENT TOOLS

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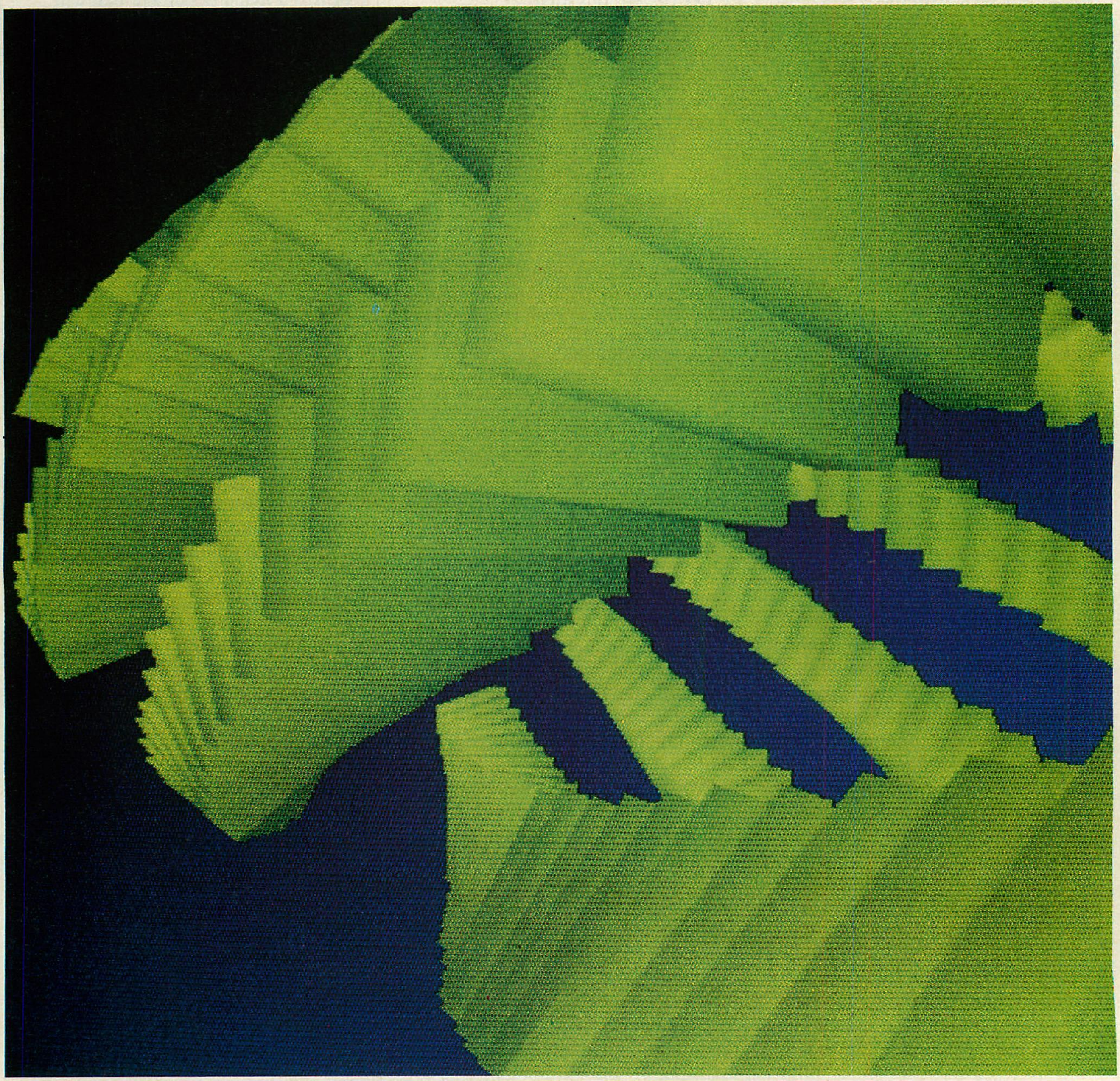


COMPUTER GRAPHICS • DOV JACOBSON

Based on the minicomputer PICK operating system, Revelation is a complex product, but not complicated. To use this data manager to its fullest involves a commitment to explore, experiment, and study a powerful, complex system.

KENT PHELPS

The trickle-down theory of economics may or may not work, but the trickle-down theory of computer software and hardware certainly appears to be alive and well. Today, operating systems, utilities, and most importantly, concepts from minicomputers are being applied to desktop microcomputers.

Revelation by Cosmos is an example of this trickle-down effect. It is a derivative of the PICK operating system, available for many years on a variety of minicomputers. Revelation features not only compatibility with many PICK-based minicomputers and their software and file structures, but an applications development environment that lets the programmer worry about the logic of the problem while the operating system worries about its mechanics. Revelation is flexible, easy to modify, self-documenting, and usable by a novice once the system is set up. Its price of $950 is somewhat more than the average data manager, but its development environment is filled with powerful tools.

The designers of Revelation perceived the need for a development environment that would function more like the real world than like a computer lab, an environment where the requirements change as the application progresses, where the cost of software maintenance exceeds the initial cost of the software within a year, where the application must be able to provide answers to one-time questions.

The basic specifications indicate Revelation's scope: an unlimited number of files open at one time, a limit of 65,000 characters per record, with 65,000 fields per record, 65,000 characters per field, relatively unrestricted data types, and an internal calculation range of $\pm 10^{\pm 4,932}$. Precision for data output is 14 digits to the left of the decimal point plus 4 digits to the right; input is allowed to 18 decimal places. Exponential notation is supported as well. Total disk space is the only limit on number of records per file or number of files in a database. Revelation was designed from the start to use the 8087 numeric coprocessor, but will run with a software emulator automatically if no 8087 is detected.

While Revelation can be used in a floppy-disk configuration, it is really at home on a large memory system with hard disk(s). The programs, which are easily installed, are not copy protected and can be readily copied to a hard disk. Because it uses a demand-paged virtual memory manager with 65KB buffers, Revelation needs at least 320KB to run; any memory beyond that simply means less disk access, the traditional bottleneck on complex database systems. If Revelation must be run on a floppy-disk system, a RAM disk might be beneficial to hold the system files that the user does not often need to access. However, a RAM disk should not be created at the expense of sufficient free memory to run the application.

MINICOMPUTER INTERFACING

Revelation has facilities to transfer a file or a record between a PICK operating system minicomputer and the Revelation environment. In order to combine the established installed base of PICK minicomputers with independent workstations, such as PCs running Revelation, Cosmos devised an offshoot of the Alternative Filing System, a generalized file system and device interface that is hardware independent.

One part of this scheme is an additional product from Cosmos called R/COMM, which allows Revelation to attach the resources of an entire minicomputer as just another logical drive and to retrieve files without special actions on the part of the operator. If the need is to store large amounts of data and have direct access to any record, more than one disk can be used. For example, 600MB of data can be spread across ten 60MB disks on a network, each disk holding portions of the same large file. If a network of PCs and file servers is required, Revelation's R/LAN interface can be configured for any one of several LAN protocols.

Because Revelation is very close to the PICK operating system, which is used worldwide, thousands of programs could be moved over to Revelation with a little bit of work. Cosmos publishes a listing, updated every three months, of applications written specifically for Revelation. Cosmos has runtime modules available for $200; the company will negotiate limited site licenses and will work with developers closely on unusual applications.

Revelation includes minicomputer communications ability and a terminal emulator (TERMINAL and PORT commands) as part of the basic package. An applications generator (R/DESIGN) and report processor (R/LIST) speed database definition and ad hoc reporting. The programming language (R/BASIC) includes external subroutines with parameter passing, named COMMON areas, structured coding features, and a full interactive symbolic debugger.

REVELATION AND DOS

Revelation is an application running on top of DOS, not an operating system itself like PICK. The PICK operating system is available on IBM PCs and ATs, but when it is running, no DOS functions are available. Revelation, on the

other hand, depends on DOS for its elementary functions. Compromises are made within this interface, but it allows both systems to lend the best they have to the task at hand.

Several interfaces exist between Revelation and DOS. The simplest is the command, PC, which executes the remaining command line as a DOS command within the limits of memory, returning to the Revelation command processor when finished. Therefore, all DOS utilities (and programs) are available to the operator at the command level. Within R/BASIC, the statement PCPERFORM accomplishes the same objective and is the only language interface available. This allows an R/BASIC program to run any DOS program no matter what the language. When doing so, the DOS file system in general is seen as a file from within Revelation, and DOS files are treated as records in that file.

These DOS interface commands allow the user to select any DOS program editor or word processor that produces ASCII files, but Revelation supplies two editors itself: R/EDIT, a line editor supplied mostly for ex-minicomputer programmers, and R/TEXT, a full-screen text editor that contains most word processing functions. R/TEXT also is available within R/DESIGN in places where free-form text entry is required.

Memory-resident programs such as SideKick work with Revelation, and most of SuperKey coexists.

Full path-name support of DOS files is available, although clear instructions on this topic are lacking in the documentation, especially with respect to creating subdirectories under Revelation and accessing them as logical disks. Each user may have his or her own set of files in a separate subdirectory while sharing common system files from the default drive. The ATTACH command is used to locate a group of files and make them accessible to the current user. Revelation keeps the correspondence between DOS files and the Revelation internal name, so the 11-character limit on DOS file-name length does not apply, and files can be assigned meaningful names.

Revelation is based on the relational model of database design; the relation is established by the presence of a common identifier in the two files, such as a department code in an employee master file. Data redundancy is minimized, therefore, by keeping the department description in only one place; all references to the employee master file requiring the printing of the department description do an automatic temporary JOIN to the department file to retrieve the description. (The retrieval language, R/LIST, does automatic JOINs on a record-by-record basis without the need to create a third file.) Because the department description is located in one place, all reports print that information identically, and a change of the department name from "Personnel" to "Human Resources" is immediately effective everywhere.

The use of this facility is not always desirable, because it forces additional disk reads and file OPENs. For small data items, it may be faster to accept the redundancy and keep the raw data in the record itself, so that all the data necessary for the typical query come into memory at one time.

Revelation's demand-paged memory manager feature means that once a file is read into memory, it remains there unless it falls to the bottom of the most recently used queue. In that case it is written back to disk if it was changed, or thrown away if it was not changed. In any case, if no activity has

occurred in 30 seconds or so, the memory manager checks for changes and copies the file to disk automatically if changes have been made. For many applications, therefore, the memory manager takes the place of both a cache memory subsystem and a RAM drive, without any intervention by the user or special instructions by the programmer.

FILE STRUCTURE

Revelation files consist of variable length records containing variable length fields. The package offers two types of file structures, ROS and LINK, both of which are written to disk as normal DOS files. With files under 200KB in size, the ROS file structure should be selected; records are stored as sequential strings in groups of DOS files, each up to 65KB in length. Once the correct DOS file is determined (by the record key), as much of the file as necessary is read in until the desired record is found or end of file is reached, which indicates to the user that the record is not present. ROS files cannot be shared in a network.

With files that are more than 200KB, the LINK file structure, which allows sharing of files in a network, should be selected.

With files that are more than 200KB, the LINK file structure, which allows sharing of files in a network, should be selected; LINK files are stored in one DOS file as a series of 1KB *frames*. Each frame has a pointer to the next frame in the chain. LINK files are a variation of the Alternative Filing System. The physical location of data is separated from the logical access to it.

Record retrieval is accomplished by a direct access method based on modulo arithmetic and a hashing algorithm. When a ROS file is created, a modulo is specified, which is the number of distinct DOS files created to hold this file's records. To find a record, the system takes the user-defined ID or key, applies the hashing algorithm, and comes up with a number. This number is combined with the modulo to find the group in which that record is located. If the modulo is sufficiently large for the number of records and the statistical distribution of the record keys is uniform, then finding one record should not take longer than any other—no matter how large the file. Ideally, a record is found in one disk access.

A ROS frame can be as large as 65KB, and normally each group has one frame. If more space is needed because of an unexpectedly large number of records written into the file, the system expands automatically by attaching another frame to the group. However, doing this will increase the disk-access overhead. The system command RECREATE-FILE can be used to restructure the file system as desired.

Each record is stored with a byte count field followed by the record ID and the record. Adding fields to the database later has no impact on the fields previously defined, because all records and fields are variable length. Everything shifts as necessary to accommodate new data.

With variable length records, if Revelation reads the first record of a group and decides that it is not the one it is seeking, it can skip *n* bytes directly and read the next ID and so on until the ID is located or the program determines that the record does not exist. If for some reason the system reads ahead the specified number of bytes and does not find another byte count field and record ID, the file is considered to be corrupted, and a "FRAME FORMAT ERROR" message is returned. Memory changed by static, hardware failure, or writing to a full diskette are usually responsible for this. The situation can be remedied either by editing the file in question and resetting the byte count fields or by using the instructions provided by Cosmos. Recovery of every damaged file may not be possible, so backups of the file system are highly recommended. No other recovery techniques are available, and transaction logging is not a part of the system.

Because the Revelation file system is variable length, and records are hash-encoded into the appropriate DOS file, file compression techniques are not needed. Operating as a virtual memory system, Revelation updates files in memory; if a record is deleted, the Revelation file group (a whole file to DOS) is restructured and written out to disk if needed. Within R/BASIC, the programmer can force a FLUSH to rewrite buffers to disk and do a GARBAGE-COLLECT, which releases unused string space in order to ensure maximum free memory is available.

In the spirit of a high-level language, and at some sacrifice of disk

space, Revelation stores all types of data as ASCII strings in the file system. This helps insulate the programmer from how a task gets done and lets him or her concentrate on the conceptual aspect of the problem. The programmer does not have to be concerned with REALS, INTEGERS, DATES, etc. This means that the system will let a programmer make mistakes. If the system returns the correct answer without complaining, it does not necessarily indicate that the programmer has written maintainable and efficient code.

The data dictionary is the focus of the Revelation system; it not only defines the data files to the outside world, but also manipulates the data. Three primary features distinguish Revelation's dictionary from most others: output conversions, integral R/BASIC code, and in-context documentation.

Dictionaries are responsible for I/O transformation of the data. When a programmer specifies a conversion code or pattern match, the data transformed as input and output occur on a record-by-record basis. This means that special synonym dictionary entries can be created for special purposes—for example, when a field should be displayed with a leading minus sign on a data entry screen, but shown with a CR suffix on a financial statement. Pattern matching and checking input for ranges of values, table look-ups, and default values all can be specified.

Revelation dictionaries also allow the insertion of R/BASIC code to perform special functions. A fragment of code is written into a dictionary as if it were an R/BASIC program. Special variables are available that are known both to R/BASIC and to the R/LIST processor, such as the current record ID, the file variable of the dictionary file, and the string array that is the current record. In addition, Revelation has five user variables that remain set throughout a session (LOGON to LOGOFF) unless explicitly changed and five recursive variables that are saved during certain functions. The result of all this R/BASIC computation is returned in a special variable called @ANS.

In effect, a piece of code can be written in dictionaries within the context of a fully developed reporting system, and as long as certain rules of conduct are followed, the user can manipulate the data desired without having to write the whole program. This process does not replace R/BASIC, but it considerably expands the usefulness of the dictionaries beyond simply displaying data. As the dictionary item construction is completed with the aid of the applications generator, the relevant instructions are compiled and the compiled code is stored in the dictionary, so that the report processor can jump directly to executable code as it processes the report. No interpretation is necessary at runtime. Table 1 shows the dictionary information for the Total Payment field in the ARTICLE file of the sample application used to evaluate Revelation for this article (see below). Total Payment is a computed field created by adding together the Payment and Bonus fields.

R/LIST AND R/BASIC

Revelation's R/LIST query language is a nonprocedural, somewhat natural, command-driven language. It expects a verb to be the first word (LIST, SORT, SELECT) and a file name to follow. Next in any order may be a series of WITH, WITHOUT, OR, and AND clauses that determine the selection criteria, some BY clauses if a sort is requested (SORT AUTHOR BY LAST.NAME), and option specifications (BREAK-ON, AVERAGE, TOTAL, SUM, HEADING, FOOTING).

The command processor parses the sentence, reads the file, builds lists of records that qualify, consults the dictionary for how to display the data, and formats the report to printer or screen. Any data in any file can be accessed if the appropriate dictionary entry is made specifying how to find the data if they are not stored in the current file. Data that are not in any file but that are computed on the run may be LISTed and SORTed as though that data actually were in the file. Multiple sort keys on multiple files can be used at one time.

The command SELECT is used to index a file, which speeds processing time. The system collects and holds a list of the records meeting the selection criteria sorted in the requested order. This list then may be fed to a report request for display or an R/BASIC program for record-by-record processing. Alternatively, the command SAVE-LIST {listname} stores the record IDs that fit the selection criteria in a system file called LISTS. Later, the command GET-LIST {listname} is invoked to prepare the list for processing or display. In certain situations, a select statement may not be easy or even possible due to the nature of the data. The programmer may just write a list of the record IDs of interest, and the command FORM-LIST {filename} {recordname} will read this list to form a select list.

The language supplied with Revelation, called R/BASIC, has a name that is

TABLE 1: *Dictionary Definition*

ITEM #	ITEM	VALUE
01	File Name	ARTICLE
02	Field Name	TOTAL PAYMENT
03	Single/Multivalued	S
04	Field Type (F, S, G)	S
05	Field Number	
06	Which Part of Key	0
07	Output Conversion	MD2,
08	R/BASIC Formula	@ANS = {PAYMENT} + {BONUS}
09	Justification	R
10	List Display Length	8
11	Edit Patterns	(MD2)
12	Bottom Screen Prompt	TOTAL AMOUNT PAID FOR THIS ARTICLE
13	LIST Column Heading	TOTAL PAYMENT
14	Source of Information	
15	Description	THIS IS THE PAYMENT PLUS THE BONUS

Three primary features distinguish the Revelation dictionary from most other data dictionaries: output conversions, integral R/BASIC code, and in-context documentation. The Total Payment field in the ARTICLE file of the sample application is created by adding together the Payment and Bonus fields.

quite misleading. R/BASIC is much more powerful in database manipulation than any other BASIC language. With its wide variety of constructs and functions, R/BASIC is a generic language; FORTRAN programmers tend to write R/BASIC programs that look like FORTRAN, and COBOL programmers write R/BASIC programs that resemble COBOL. R/BASIC is not a strongly data-typed language, so with some discipline, programmers can write the programs they want. Creating a production-quality program that can be maintained by someone else may require extensive initialization and adherence to local programming standards, but to write a quick and dirty utility program does not require a preamble rivaling the Declaration of Independence.

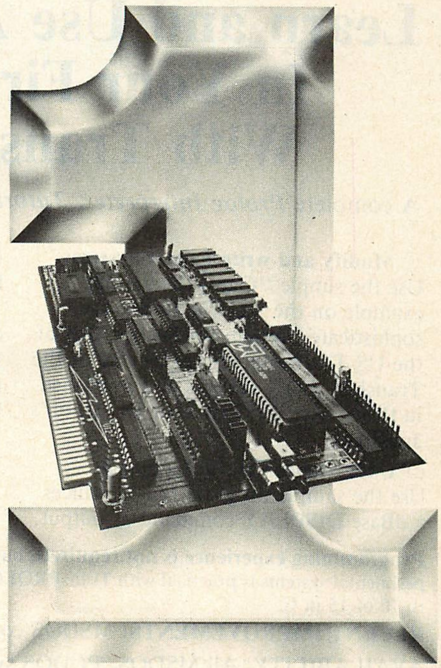
Some combinations of data or processing features are not possible with R/LIST, and an R/BASIC program must be used. This is the case when data cannot be displayed sequentially, or some special processing must take place. R/BASIC has some speed advantages over R/LIST, but the development time is orders of magnitude greater, and programs are more difficult to maintain. The moral of this story is: if ad hoc reporting is important, design the layout of the files and the types of data that are stored in them with R/LIST in mind. R/BASIC can handle anything, but a wise designer will let the Revelation processors do most of the work.

R/BASIC can be used for special tasks, such as sending data to a variety of printers. Using a configuration table for the appropriate printers, R/BASIC can send control codes to each printer under complete program control. For a particular field, a dictionary entry could be made to prefix data with printer codes that call for a special feature, send the data, and turn off the special feature while running an R/LIST report.

Within R/BASIC, virtually all standard programming constructs are available, including FOR/NEXT, LOOP/REPEAT (and LOOP WHILE, LOOP UNTIL), CASE, IF/THEN/ELSE, GOTO, and GOSUB. COMMON declarations, both labeled and unlabeled, are available. These can be a very powerful tool in coordinating development of groups of programs, in passing parameters, and in ensuring all programs within the functional module use the same parameters. Statement labels may be numeric or alphanumeric. The BLIST command from the terminal produces a formatted, structured output of the source code to the printer to clarify logic flow.

Among special features, the $INSERT statement is useful because it tells the compiler to merge source code into the program during the compile. This allows the use of standard COMMONs for parameters; a change to the COMMON area is automatically included in a source file. $INSERT can be used to insert common internal subroutines, EQUATE statements, or whatever needs to be standardized among a group of programs.

Internal and external subroutines are available and may be recursive. Parameters may be passed either in COM-



MON areas or explicitly in the subroutine call. All labels and other variables not passed are local to the subroutine.

Because of the unique way in which Revelation handles them, arrays are of particular interest. Two-dimensional arrays are supported, with commands such as MATREAD, which both reads the item and assigns values to the elements of the matrix. These elements are addressable in the normal fashion—ARRAY(1,2). Element 0 (ARRAY(0,0)) contains the number of elements filled with data if this number is less than the dimensioned size of the array. This is useful for keeping loops to the minimum number of iterations that are necessary.

In addition to dimensioned arrays, Revelation supports dynamic string arrays, and typically these are used more than are dimensioned arrays. The array is stored as a variable length string (up to the 65,000 limit) with system delimiters separating the elements. Fields of a record are separated by field marks (ASCII 254); within fields may be substrings called *values* separated by value marks (ASCII 253). They, in turn, may contain a series of subvalues separated by subvalue marks (ASCII 252). In effect, Revelation is a relational system with a hierarchical subsystem.

> *Debugging an R/BASIC program is handled in two ways: through a smart compiler or an interactive symbolic debugger.*

The choice between dynamic or dimensioned arrays is a compromise. Dynamic arrays are long strings, so the search for <ITEM100,34,22> requires reading the entire string and counting delimiters along the way until the correct piece of data is found. A dimensioned array is resolved by the compiler as an address into the data space. Thus, accessing ITEM(1354) is no more difficult than ITEM(2), but data space for the entire array must be reserved even if all elements have not been assigned a value. This is an example of how a programmer with a good grasp of the software/hardware interface can write efficient programs.

String processing is very flexible, because it is the basis for dynamic array

manipulation. Concatenations, substring extractions and insertions, and string compares are available. Therefore, interfacing with fixed-length-field systems, blocking the data from the variable-length source files into a format suitable for the outside world, is quite easy. The dynamic array system includes the ability to build a sorted array, using the LOCATE statement. Instead of creating a file of data, then sorting it in a particular order for some purpose, the user can invoke LOCATE to find the position of an element in a dynamic array. If the element exists, the array position is returned. If the element does not exist, the array position where it should be inserted, based on ascending or descending sequencing, is returned, and the INSERT function places it in the proper location. Elements can be retrieved from a variable with the EXTRACT function and removed from the array with the DELETE function.

Revelation can store all numbers and dates in what is called *internal format*. Dates are numbered sequentially from December 31, 1968, which is day 0. All subsequent days are positive numbers, and all previous days are negative. Date arithmetic then is a direct subtraction or addition. The date is converted by a dictionary instruction for output in any of several formats. For example, December 25, 1973, is stored as 2186. Different reports or programs, operating on the same data, could display that date as 25 DEC 1973, 12/25/73, 25 12 73, or five other choices.

An additional benefit is that the date consumes only four characters in the database. Other numeric fields are stored with only the digits required for the task, and formatting rules are applied when the data record is retrieved. $12,345.20 is stored as 1234520 in the database, and if a check were to be printed for this amount, the command PRINT OCONV(1234520,"MD2$,12*"), where MD stands for a masked decimal conversion, would print $**12,345.20. All the common formats for numbers in business, including debit and credit indicators, trailing minus signs, truncation or rounding, are available through the conversion process.

USING THE LANGUAGE

R/BASIC is a compiled language. Even the query language R/LIST parses the command line and writes an R/BASIC program to perform its task, resulting in a six-second delay or so while it compiles. Although it adds to the time an ad hoc query takes to execute, this R/BASIC intermediate step allows some clever solutions to be applied when trying to get a report just right. An option on the command line for an R/LIST report causes it to save its R/BASIC program to disk, where it can be examined and modified if necessary.

Debugging an R/BASIC program is handled in two ways: through a smart compiler or an interactive symbolic debugger. The compiler is fast and will report most errors of syntax and construct, but it is not as smart as minicomputer versions of PICK BASIC. Some fairly obvious errors may be caught only at runtime. The debugger can be invoked by inserting a DEBUG statement in the source code or by pressing Ctrl-Break. (The R/BASIC command BREAK KEY OFF or ON will disable and then reenable the ability of Ctrl-Break to invoke the debugger.) The program stops at that point and traps to the debugger. This allows the user to set breakpoints, examine or change the value of any variable in the symbol table by name, set the multistep line counter, and set up trace tables.

Most of the techniques applicable to Revelation apply to other computers running the PICK system, so the database design, file layouts, data, and most R/BASIC program code can be moved to a PICK minicomputer. Revelation incorporates many features specific to its implementation on the PC that are not found on a minicomputer; therefore, portability problems may arise. Generally, transporting software written for a PICK-based minicomputer to Revelation is the easier direction to follow, unless the programmer has a target machine in mind and structures the design around the features on that machine.

A knowledge of R/BASIC is the key to using Revelation's applications generator, R/DESIGN, to its fullest. R/LIST is very flexible for retrieving data; most of R/DESIGN's work is in setting up the database and entering data. R/DESIGN works well in this capacity. If special forms are needed, R/FORM, an output forms utility, allows the building of the form with the full-screen text editor. The dictionary name of the item desired is entered at the location on the screen where the information is to be displayed, and R/FORM combines the form layout with the record information as designated by the dictionary. This is a great feature for statements, checks, and other format-specific documents.

R/DESIGN programs ask for but do not require information about the dictionary items being defined; the system uses this information to provide context-sensitive help in data-entry

screens and to create a complete document describing the function of the R/DESIGN program and files handled. The documentation describes the file layout, shows the comments entered for each field, and generally consolidates the essential information about a file and/or a program in one maintainable place. With planning from the applications developer in designing comments, this system could be sufficient for an end-user manual. A sampling of the documentation generated by R/DESIGN for the AUTHOR file maintenance program of the sample application is shown in figure 1.

Revelation's SORT and SELECT processor operates through the data dictionaries. In normal use the Revelation system does not use prepared indexes, although indexes are available as needed through R/BASIC. All system processors except R/BASIC require the dictionary to find where the data are stored, and R/BASIC may use the dictionary if desired. The user need only know the name of the file and the dictionary name of the information requested, and the system will find, compare, sort, and display it as specified by the dictionary.

A sentence that is typed at the terminal is parsed by the command processor in a nonprocedural fashion, the specified file or files are opened, the requested pieces of the database are retrieved in the order specified, with the records themselves sorted if necessary during the retrieval process. Because Revelation's dictionary system allows for the creation of symbolic or computed fields, a dictionary reference may be created for data that do not really exist in the data file. Even symbolic data may be used in order to perform a JOIN to another file on a record-by-record basis; this is done either to link files together dynamically for a particular request or to produce a computed field for R/FORM to display on a report.

SYSTEM SECURITY

As on a minicomputer, a Revelation user logs into an *account*. This is part of the inherent multiuser nature of Revelation's design. The only files that can be accessed are those recognized by that account. The master dictionary for an account, or VOCabulary, is a VERBS file of commands and file references that define which functions are available to that user. If a particular command is not present in the master dictionary or the VERBS file, it cannot be executed unless the user inserts it with the editor. However, if the EDIT command is removed, that is not possible either. Common files can be shared among several Revelation accounts by defining them in each account as an actual location (account) within the Revelation system. A file belonging to another account can be accessed temporarily by setting a file pointer; that file then can be accessed just as if it belonged to the current account.

Each account may have a password that must be entered by the user at log-on time. Data-entry screens created with R/DESIGN may have a protected attribute set for any field to make it display only. No file encryption exists in the Revelation system proper—nor on PICK minicomputers. An encryption program may be written in R/BASIC, however. A dictionary entry could be set up to decrypt a field by calling an R/BASIC decryption subroutine, which is provided on the system only in object code. The decryption would be possible only if the appropriate account name were requesting the report.

The application used to test Revelation for this review has three files:

FIGURE 1: *Sample Documentation*

```
DOCUMENTATION for AUTHORS
Generated 00:13:15  12 NOV 1985

Program name :  AUTHORS  (Enter/Retrieve information from the AUTHOR file.)
Type         :  ENTRY           Language : BASIC          Inscreen : N

This is the program that maintains the AUTHOR file. The file is keyed on
author number, and if entering a new author, a carriage return at the
'AUTHOR NUMBER ' prompt will assign the next sequential number available.
When finished with entry or update, a <CR> or 'FILE' at the change prompt
will file the record. 'END' will abandon the changes.

The following are the prompts for program AUTHORS

DICTIONARY FMC  SM  CONV PATRN   R/O FRMT DFLT VFILE MV.NO MV.SZ DEPTH KEY
---------- --- ---- ---- ------- --- ---- ---- ----- ----- ----- ----- ---

AUTHOR.NUM 0    S        ON       R  L#6  %S%                          KR
FIRST.NAME 2    S        %LC%     O  L#12
MI         11   S        0A       O  L#3
LAST.NAME  1    S        %LC%     R  L#18
ADDRESS    3    S                 R  L#20
CITY       4    S        %LC%     R  L#16
STATE      5    S        CO ...   R  L#2
ZIP        6    S        5N ...   O  L#5
W.PHONE    7             10N ...  O  L#12            0     0
H.PHONE    8             7N ...   O  L#10
SSAN       9                      O  L#10
BIO        10   S        %LC%     O  T#78                        8
CHANGE     0             ON ...   O  L#60

COLUMN EXPLANATIONS

FMC=Field number, SM= Single or Multi-valued, CONV=Date, time, or decimals
PATRN=Editing patterns, R/O=Required or Optional, FRMT=Display format
DFLT=Null Defaults, VFILE=Files verified against, MV.NO=Multi-value
window #, MV.SZ=Multi-value window size, DEPTH=Depth of multi-lined prompt,
KEY=The Key

Descriptions of prompts for program AUTHORS

Prompt : 01  Author #
This is a sequential number assigned to the author for future reference
throughout the system. If a null is entered ( a 'CR' ) the next rext
available sequential number will be assigned.
Patterns : ON

Prompt : 02  First name
Author's first name is contained here. This allows searches on a first
name field rather than having to do a substring extraction on a combined
lastname/first name field. No additional space required
Patterns : %LC%

Prompt : 03  MI
Middle initial of the author if needed. May actually be a middle name or
several initials (i.e. J.D. ) if needed.
Patterns:  0A

Prompt : 04  Last name
Last name of the author contained in this record is stored here. Any
length is acceptable.
Patterns : %LC%

Prompt : 05  Address
Address field of Author's mailing address

Prompt : 06  City
City of residence
Patterns : %LC%

Prompt : 07  State
State of residence
Patterns : CO,WY,NB

Prompt : 08  Zip Code
Zip code for mailing
Patterns : 5N,5N'-'4N

Prompt : 09  Work phone
Phone number(s) at work..enter just the numbers, either with area code or
without.
Patterns : 10N,7N

Prompt : 10  Home Phone
Phone number at home. One entry allowed.
Patterns : 7N,10N

Prompt : 11  SSN
Social security number. Used to withhold needed money from young starving
authors to support old starving authors

Prompt : 12 Biography
A (hopefully) succinct description of the life and times of this
particular author.
Patterns : %LC%

Prompt : CHANGE
"CHANGE" Prompt.  Allows the user to enter Ctrl-T or "TOP" to clear the
screen, Ctrl-E or "END" to exit the screen with no update, Ctrl-D or
"DELETE" to delete the record, "FILE" or press <E> to file a record on
disk.
Patterns : ON,"FILE","DELETE"
```

The documentation generated by R/DESIGN describes the AUTHOR file layout of the sample application, shows the comments entered and the conversion patterns for the display of each field, and provides other essential information as well. It is system-maintained, on-line, and a giant step ahead of a system that does not work with a documentation processor.

AUTHOR, ISSUE, and ARTICLE. (For a complete explanation of the sample application, see "Sample Application Specifications," August 1985, p. 48, or download it from PCTECHline.) The AUTHOR file consists of information on each author: name, address, phone, etc. The ISSUE file contains the deadline date for the issue in question, and the record keys are the volume concatenated with an asterisk concatenated with the number of the issue within the volume; thus, volume 4, issue 1 is 4*1. The ARTICLE file, which is the main file, contains data fields such as titles, date received, payment, author codes, article size in pages, and the category into which the article fits. This file also contains information linking it to the ISSUE (volume and number) and AUTHOR files (author number).

For the sample application, several ad hoc reports were to be generated. In addition, some specialized reports were to be programmed in order to summarize the articles by issue, to print mailing labels for authors in an issue, and to prepare a summary report by author and year, which lists titles, issue references, and payment data. Different aspects of Revelation were used to accomplish each of these tasks.

To obtain a list of names and phone numbers of authors who have missed the deadline for their articles, sorted by issue, zip code and last name, the following sentence was typed:

SORT ARTICLE WITH DEADLINE.MISSED BY ISSUE BY AUTHOR.ZIP BY LAST.NAME BREAK-ON ISSUE
LAST.NAME AUTHOR.PHONE
AUTHOR.ADDRESS
HEADING "List of authors missing deadline Page 'PL'"
LPTR

This sentence uses a field nonexistent in the database (issue = volume + * +

number) to sort the file, followed by the author's zip code and last name; it qualifies the records by referring to the ARTICLE file for date received and comparing it to the deadline date from the ISSUE file (this is what the symbolic field DEADLINE.MISSED does, producing a Boolean result). Finally, the corresponding contents of the AUTHOR file (last name, phone, and address) are listed to the printer for each of the articles selected.

The symbolic (computed) field DEADLINE.MISSED uses the symbolic datum ISSUE to translate to the ISSUE file in order to get the deadline date field. Translating from one file to another requires that the key to the second file be compatible with the first.

Additional capabilities of the R/LIST processor, beyond the retrieval and conversion functions already discussed, were used to accomplish the second part of the sample application. These capabilities include HEADING and FOOTING, insertion of time, date, file names, line feeds, and page counters in the heading/footing, and the ability to place the value of the field being subtotaled in the heading when a break occurs in the report.

For the sample application a report was requested listing the average fee paid to authors. This sentence produced that report for a particular issue:

```
LIST ARTICLE WITH ISSUE EQ "?ISSUE?"
PAYMENT AVERAGE PAYMENT
BREAK-ON ISSUE "Average For 'BV' "
HEADING "Listing of Average Fee For
  Issue 'BT' page 'PL'"
```

The word ISSUE surrounded by question marks causes R/LIST to prompt the operator for that value. The dictionary entry for PAYMENT is one that totals the amounts for normal payment and bonus. R/LIST notices the key word AVERAGE and keeps counters going until the break-value changes, at which time the record count is known and the average can be computed. The BREAK-ON statement specifies that each time the issue changes, the string "Average For" and the issue value will be displayed. Heading options B causes the break value (issue) to be displayed, T displays time and date, P is a page counter, and L causes a line feed.

Similar to this report was one that requested a listing of the ARTICLE file sorted by author and displaying article titles, booking information, and fee plus bonus paid per author per year. The problem here was splitting the amount paid among all the authors, because in some cases multiple authors were responsible for one story. These split fees require an R/BASIC program. To get all authors in the list in order when some of the articles had more than one author requires an *exploding sort* on the multivalued author field. R/LIST creates a temporary workspace, "explodes" the records to all unique combinations of article and author, sorts the work file, and feeds it to the R/BASIC program. The program then could read the records in order, find out how many authors were part of each article, and split the fee accordingly.

If the BREAK-ON phrase is combined with a P option at the break subtotal, a separate page is issued for each different group of subtotals. For example, if an invoice file was sorted by vendor, and the above options were used to ask for total invoices by vendor, the result would be a report with a new page for each vendor, totaling that vendor's invoices and with the vendor name in the heading; these pages could be used as separate reports.

Other options/key words that are available with the R/LIST processor in-

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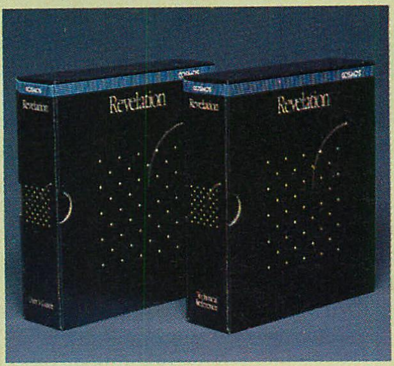
clude COUNT, which counts the items that match certain criteria; SUM, which totals a multivalued field; and GRAND-TOTAL, which allows text to be printed on the grand total line.

Report formats are controlled by the dictionary entries for the fields requested. The dictionaries contain specifications for column width and justification. Three justification rules are available: right, left, and text. Numbers must be right-justified if they are to sort properly. Text justification justifies left, but does not break the line at the column width point; it seeks the last space in the string and folds the line there, creating a much more professional presentation. If total column width of all fields requested plus intercolumn spaces is less than the width of the display device, then a columnar report is

REVELATION OVERVIEW

REVELATION, version G
19530 Pacific Highway South, Suite 102, Seattle, WA 98188; 206/824-9942

Product type. Data management system and applications environment for business applications.
Software environment. Runs under MS- and PC-DOS, version 2.0 and later, and IBM's TopView.
Network support. IBM, Nestar, Novell, Gateway, Corvus, PCNet, Banyan Systems, and Santa Clara Systems.
Hardware environment. IBM PC, PC/XT, PC/AT, and IBM compatibles with a minimum of 320KB of RAM and two floppy-disk drives. Also supported are additional RAM, system-compatible hard-disk drive, and 8087 coprocessor.
User interface. The program is command language and menu-driven and uses macros/procedures and function/control keys. The command language, data definition, and data manipulation are all English-like.
File limitations. 65,000 characters per field; 65,000 characters per record; 65,000 fields per record; unlimited records per file; unlimited open files; unlimited indexes per file. The program allows a file to span multiple disk-volumes, and stores data in variable length records. Uses both relational and free-form data dictionary architectures.
Access to system facilities. From within the program the user has the ability to access all DOS functions.
File modification facilities. The program can merge two or more files into a single file, and can split a file into two or more files. The program can update a file with data from another file, and can update multiple files simultaneously. Fields can be added without loss of data in a file.
Help facilities. On-line, context-sensitive help, a written tutorial, and a quick reference card are provided.
File design. The product uses a screen-painting method of entry-screen design that allows custom



data-entry screens. The user may create multiple data-entry screens for a single file, which may be more than one screen in length. The program supports derived fields using information resulting from calculations, from another file, and from a user-supplied list or file of acceptable values. Also allowed are view-only fields, numeric fields, user-defined numeric formats, must-enter fields, and double-entry fields that force the operator to reenter information to verify accuracy.
Data entry. The program automatically checks for duplicate entries in a file; provides range checking functions; allows standard entry values during entry; and provides facilities for batch data entry.
Query and sorting. Search facilities allow for partial key search and selection and logical operators. Sorts can be performed in ascending and descending order. The program supports multiple sort operations on up to 128 fields and multiple indexes on unlimited fields. Query and ordering specifications may be saved for repeated use. Automatic updating of indexes is supported.
Reporting. The program produces label reports that produce two-or-more-across labels. Report formats can be edited and can contain information from two or more files. The program also produces summary reports that can include totals, subtotals, control breaks for pagination, and calculated results using four-function math, parenthetical control of order of operations, averages, and trigonometric, transcendental, and string operations. Reports can be directed to the screen, printer, or choice of multiple printers. Print enhancements such as bold and underscore are supported and the user may specify paper size, margins, etc. in the report definition.
Security. The program provides password-protected access to the program itself and to program fields. Multiple levels of password protection may be programmed through the dictionary.
Utilities. The program provides file maintenance utilities, conversion utilities for translating dBASE and Lotus files, and print-outs of report and file-design definitions.
Applications development facilities. Customization is possible with macros/procedures and custom menu generation. The program provides a fully programmable procedural language, links to DOS applications or other languages, and can generate turnkey applications. A runtime compiler or module is available for use with applications developed.
Data compatibility. Program reads DIF, Lotus, dBASE, comma-delimited ASCII, and fixed-length ASCII file formats.
Special features. The program provides integrated, variable length and width text windows within screen generator.
Delivery. Began in May 1983; current version first delivered in May 1985.
Distribution. Primarily through distributors, dealers, systems houses, and consultants.
Price. $950; Runtime version, $200; Network Revelation 4-user license, $1,495; 10-user license, $2,995; 32-user license, $4,995.
Support. The product includes on-screen tutorials, sample applications, telephone support, demonstration disk, and end-user training. An update/maintenance plan is available for $50. Backups are allowed for personal use.

generated. Otherwise the system goes to vertical format, where one record at a time is displayed with each field requested on a separate line.

Another task in the sample application was to print some labels. R/FORM could accomplish that in only a few moments, but with one drawback: duplicates could not be easily eliminated. An R/BASIC program had to be written in order to meet the specified criteria. The end user must decide if eliminating some duplicate labels is worth this extra programming time.

REFORMAT, an undocumented verb that is on the system but not working completely, could be a solution to this problem. When available, REFORMAT will make a selection of one file and write it to another file or the same file in an inverted format, with a new record key and consisting only of the fields specified in the command. In the example, the system could eventually REFORMAT the selected list of authors' names to a file with the author names as keys and the address information as fields, so duplicates would overwrite one another. Then that file would be used to print the labels.

Once a report is constructed as desired, and if it is a routine report, the sentence that creates it may be saved in the master dictionary of the account as just another verb that, when typed, displays the entire report. For this purpose, a sentence may be constructed to prompt for a desired value, making the report more generic. The sentence

```
SORT ARTICLE FILE
WITH ISSUE EQ "?ISSUE?"
BREAK-ON AUTHOR
TOTAL PAYMENT TOTAL PAGES
```

could be saved as PAYMENT.REPORT (no spaces), and all the end user needs to do is type the verb, answer the prompt ISSUE?, and get the report.

As an aid to using and developing R/LIST sentences, the system command processor keeps a stack of the last 10 commands. These are available for inspection by entering .L. Any command can be brought to the terminal buffer by .Xn; it may then be edited as necessary with Ins, Del, and arrow keys before being executed. Once a sentence is correct, it may be saved in the master dictionary with the command .Sn name. Thereafter, that name is a verb that will run the sentence just as if it were typed at the terminal.

In the above sentence, the word FILE was used as a throwaway word to increase the readability of the sentence. In this location in the sentence it is ignored by the command processor. Other throwaway words are A, ANY, AN, HAS, OF, THAN, THE. Thus, the following sentence also is acceptable:

```
SORT THE ARTICLE FILE
WITH ISSUE EQ '3*4'
IF THE AUTHOR HAS A LAST.NAME OF
  'Wheeler'
```

MULTIUSER APPLICATIONS

Cosmos has a novel approach to integrating multiuser features into Revelation. The product has its origins in minicomputer, realtime, multiuser operating systems; thus, all necessary syntax has been available in R/BASIC since inception. Single-user applications ignore the locking logic, so the programmer can design systems with multiuser environments in mind from the start.

Cosmos has attempted to carry system design forward with the same spirit in which the PICK system was invented: to be hardware independent as much as possible. Therefore, the LAN interface is a generalized I/O interface that can support any of several types of LAN hardware, including Novell, Nestar, and 3COM. Revelation can handle the retrieval of files from a remote device without the operator knowing where the data reside. Cosmos has provided an improvement to standard PICK BASIC in this area; many minicomputers lock the group in which the data reside, but R/LAN locks the record. The lock is only for update, so several users can read the record at one time, but only the user who has set the semaphore lock can write the data to disk.

Data entry with R/DESIGN can be prompted either at the bottom of the screen or at a particular place on the screen. Screen forms can be made in color and use some line drawing characters, although this is a little tricky. An interesting feature of R/DESIGN is what Cosmos calls *ticker-tape display* of text fields. The dictionary specification for the field being entered determines the display width on the screen, but because the data fields have no length restrictions, entering more data than the window size can accommodate causes the line to scroll to the left until a carriage return is entered. The user may scroll back and forth within the field and change the entry as needed.

All Revelation commands must be entered in uppercase, an incongruous requirement on the PC. This is one feature that has migrated down to the PC that should have stayed at the minicomputer level. Revelation uses the keyboard of the PC thoughtfully.

The latest release of Revelation comes with some very handy tools for moving data into and out of Revelation in foreign formats. A program supplied on the utility disk called PORTER moves Revelation files to DOS ASCII files or to Lotus 1-2-3-compatible DIF format files and back again. This program is easy to run and allows considerable flexibility in moving DOS files, either with fixed-length fields or comma-delimited fields, into Revelation. It allows rearrangement of fields as the file is loaded, and any field can be chosen to be the Revelation file key. A conversion program also is supplied to move dBASE II files into Revelation format, including creation of the data dictionaries. dBASE III files can be moved with the program PORTER.

If the task is somewhat more difficult, R/BASIC has two functions, called OSBREAD and OSBWRITE, that read in a DOS file as a string up to 65,000 characters long; then from R/BASIC the file can be manipulated as necessary and written out again.

The Revelation documentation, which consists of two full binders, is among the best available for this type of system, but even a knowledgeable user will have some difficulty finding the references needed to answer all questions. The index could well benefit from a doubling in size. Several excellent sections describe the theory and philosophy of the design; these should be read carefully first. The tutorial is a sample accounts receivable system. The example programs are straightforward and probably the best way to learn R/BASIC. The sections on R/DESIGN should allow a novice to produce effective results fairly quickly. On-line help is available at the system level for information about various commands.

TABLE 2: *Benchmark Results*

BENCHMARK TASK	TIME (secs)
Add 900 records to an empty database	157
Index database on two fields (7 bytes)	—
Document and tally codes from one field	66
Mass change of one field (28 records of 900)	51
Extract selected records to create a test file	50

Revelation has a lot of overhead associated with simple tasks and may not be the best choice if speed is crucial, the database small, and Revelation's flexibility is not needed. Revelation will perform best with a large database and will be most useful when the application must be flexible and special features are needed.

BENCHMARKS

Five benchmarks were run for this article, as they were for the other data managers that have been reviewed in this series (see *PC Tech Journal* issues beginning in August 1985). The results are shown in table 2. All of the performance benchmarks in the data manager series have been run on the same PC/AT at *PC Tech Journal's* editorial offices. The same fixed-disk partition is reserved for running the benchmarks so that each set of tests is run from the same portion of the disk.

In the first benchmark, loading a Revelation file with 900 records from a DOS diskette, the PORTER program was used to read the diskette and load 900 records of the author file. It worked well and was easy to run. However, the processing time was reduced by 32 percent by writing an R/BASIC program designed for this task, using the R/BASIC ability to read the DOS file directly into a memory buffer and the R/BASIC statement CONVERT to convert the DOS delimiters, double quote and comma, to Revelation system delimiters. Compared to some other data managers previously reviewed, this is not especially fast or unnecessarily slow, but it does illustrate that a generic program written to be flexible and user friendly will invariably have more overhead than one written for the task with an eye for efficiency.

In designing this file, using the names of the authors or their Social Security Numbers as the record key would seem to make the most sense; however, a sequential number was used for this test. Because the system performs a hashing algorithm on the record ID to decide where to store it, the goal in a larger file is a uniform distribution of records throughout the file. Sequential numbers work best in this case. Also, the fewer characters in the key, the less time spent with the hashing algorithm. One last consideration is that R/DESIGN will maintain an index if so desired, so the user would always be able to find an author by last name also.

The second benchmark, reindexing the author database, is really not appli-

cable because Revelation is not an index-driven system. Creating a list of records that met the qualifications specified would be a comparable task; if this task were to be repeated in the foreseeable future the list could be saved so that another selection process would not have to take place.

Note that the system will not maintain these lists itself if records are added or deleted. In real life, however, selections are made with constantly varying requirements, so the philosophy behind Revelation is that some overhead may exist in a system that does not require indexes, and in return no restrictions are placed on the kind of select or sort that can be performed on the file data. Because of this feature, an index never has to be corrupted; every selected list is correct as of that moment. R/DESIGN, however, can maintain cross-reference index files if so desired. This would be a good idea only if the entire application were to be done with R/DESIGN, and the overhead of additional files was acceptable.

The third benchmark, counting the number of occurrences of the state codes and reporting them in alphabetical order, took 66 seconds. It is an illustration of alternative methods available to the R/BASIC programmer. In a typical indexed database system, the file would be sorted by state first and then read sequentially, keeping a running count of the state codes. With R/BASIC and the ability to build sorted dynamic arrays in

With R/BASIC and the ability to build sorted dynamic arrays in realtime, the process can skip the sort of the entire file and simply read the file sequentially.

realtime, the process can skip the sort of the entire file and simply read the file sequentially. Whenever a state code is encountered, a memory list is checked that is built as the program progresses, and a counter is incremented in a second parallel array representing the total count for that state. When done, the array of state codes is in alphabetical order, and the corresponding counts are in the matching array element. After all state codes have been read once, sorting stops and only memory addition continues. The R/BASIC code for this benchmark is shown in listing 1.

Changing the state field in selected records from CO to CL, was the fourth benchmark, which took 51 seconds. The test would have run faster using a preselected list of records with state equaling CO, but fetching the records from the database first is much more representative of a real-world problem.

The last benchmark combined a select, a sort, and the creation of an external DOS file. The test was to find all authors with California addresses, sorted by zip code, and to write the records to a DOS ASCII file. More or less the reverse of the first test, it is a good example of moving data out of Revelation for use by another program. The time of 50 seconds was longer, by far, than any other data manager tested so far.

Benchmarks are instructive if they are representative of the intended use of the product. Revelation has a lot of overhead associated with simple tasks and may not be the best choice if speed

is crucial, if the flexibility it offers is not needed, and if the database is small. Revelation performs best in relative timings when the database is large (10,000 records or more) and when the application must be extremely flexible and the special features are needed.

Revelation is indeed an extremely powerful and flexible data management tool; between R/BASIC, R/LIST, and the dictionaries, any given task may be accomplished in several ways. From a developer's standpoint, the more complex the application, the more useful Revelation will become.

After several years of proving and refining its concepts on thousands of PICK-based minicomputers, Revelation appears to be relatively bulletproof and should be an excellent development platform for serious projects.

Kent Phelps has several years experience with the PICK operating system and has worked with Revelation since it was introduced. He currently is manager of technical support for General Automation, a manufacturer of super micros and minicomputers using PICK.

LISTING 1: BENCH3.LST

```
* * *  COUNT THE OCCURRENCES OF STATE CODES AND PRINT THEM
* * *              KENT PHELPS 10/85
* * *
      OPEN "","AUTHOR" TO AUTHOR ELSE STOP
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*
* initialize
*
      ARRAY = '';ARRAY1=''
      REC = 0
*
      PRINT "START ":TIMEDATE()
      START = TIME()
*
START:
*
      REC += 1
* keep the user informed
      IF MOD(REC,10) = 0 THEN
         PRINT @(0,22):'RECORDS SO FAR ':REC
      END
*
      READ ITEM FROM AUTHOR,REC ELSE GOTO FINISH ; * none  left
      STATE = ITEM<5>  ; * get variable from rec dynamic array
      LOCATE STATE IN ARRAY BY 'AR' USING @FM SETTING POS ELSE
* if not presently in my state list then add
         ARRAY<POS> = STATE
      END
* now increment the corresponding counter
      ARRAY1<POS> = ARRAY1<POS>+1
* keep going
      GOTO START:
*
FINISH:
*
* clear the screen
      PRINT @(-1):"STATE POPULATION RECS IN THE AUTHOR FILE "
      PRINT
      PRINT "STATE    OCCURRENCES"
      FOR I = 1 TO COUNT(ARRAY,@FM) + 1  ; * number of elements
* format the items left justified, field of nine spaces
* a string of asterisks as a histogram for fun
         PRINT ARRAY<I> "L#9":ARRAY1<I> "L#9":STR('*',ARRAY1<I>)
      NEXT I
      PRINT "FINISHED !! ":TIMEDATE()
* get current system time, figure the total elapsed
      ELAPSED.TIME = TIME() - START
* convert internal time difference to output format
      PRINT "ELAPSED TIME :":OCONV(ELAPSED.TIME,"MTS")
      PRINT
* pause for a moment so the user can write down the results!
      PRINT "PRESS <CR> TO CONTINUE ":;INPUT Q
   END
```

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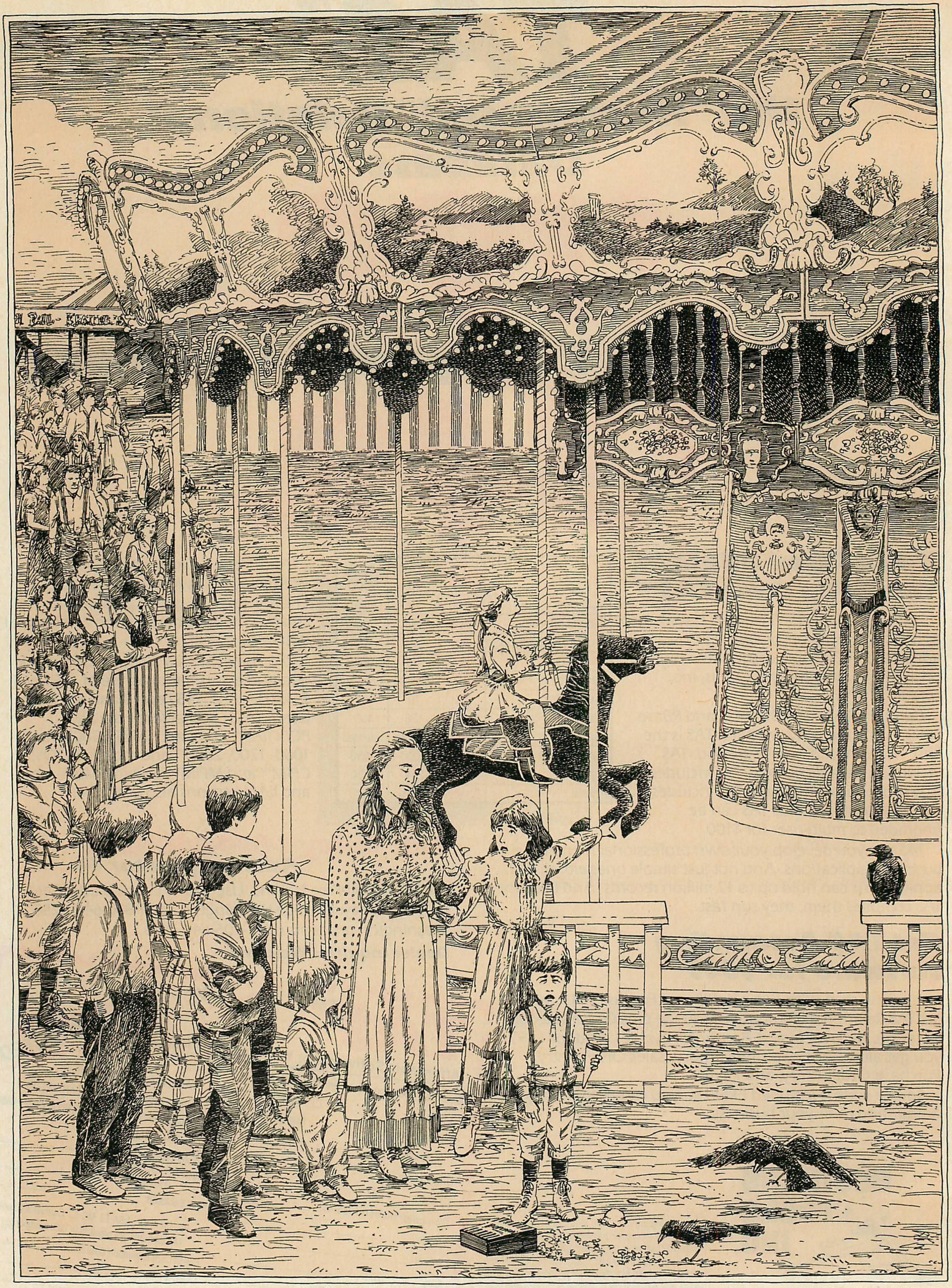

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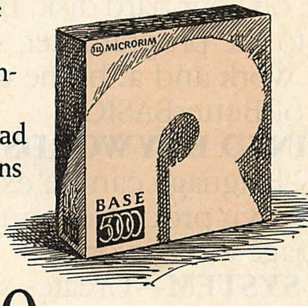

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IT ALL COMES DOWN TO COMMON SENSE.

LARRY W. LOEN

Filters and Finite Machines

UNIX-borrowed programming concepts help the DOS user find answers to otherwise complicated problems.

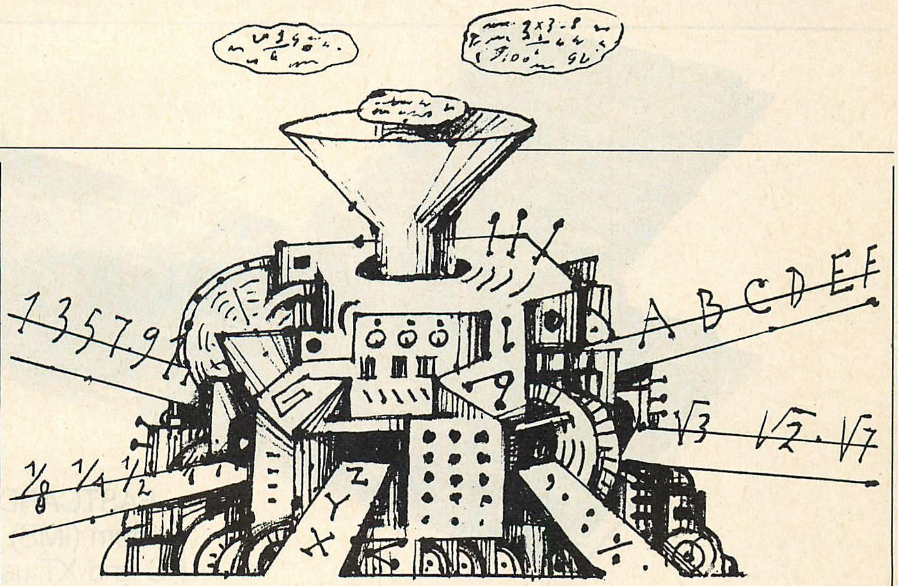


ILLUSTRATION • MACIEK ALBRECHT

Filters and finite machines are time-tested programming concepts. The former comes from the UNIX environment, the latter forms the core of compilers and many other big programs. Together, they provide some useful ways to think about programming.

Consider the author writing a book. He decides to break each chapter into its own file; this resolves many difficulties but creates a new one. The author needs a simple way to count the words he has produced. Publishers use such data to enforce word limits and gauge an author's progress. If the author knows how many total characters are in the file, dividing by 6 produces a very good approximation of the number of words. This, however, is where the problem arises. The DOS DIR command gives character counts for individual files but not for groups of files. DIR's output must be sent to a utility that will sum the file size column.

In DOS 1.0 and 1.1, no easy way existed to place the output of system commands (such as DIR) into a file. The designers of DOS 2.0 and 2.1, however, borrowed from UNIX the concept of pipes and filters. A *pipe* is a convention that allows several programs to share an I/O stream; a *filter* is a program designed to perform I/O through pipes. Pipes and filters provide the solution to the problem.

The author must use a SORT program on the data output by DIR. SORT is a filter the author can maintain separately to perform sorting on any other project. (The SORT discussed here is included with DOS 2.x.) But how does SORT know where the input comes from and where it is going? In DOS 1.0, sending data to and from a disk file looks different than sending it back and forth to the asynchronous card and so on; each interface is different. DOS 2.0, however, uses one interface and two special pipe files: *standard input* and *standard output*. The user tells DOS which kind of I/O these standard files represent by the way he types a command. Because DOS makes all sources look the same, SORT is relieved of the recognition responsibility.

The standard input file is a stream of characters that could have originated from the keyboard, a disk file, the asynchronous card, or the output of a previous program. Standard output can be sent to the screen, a disk file, the asynchronous card, the printer, or the standard input of the next program.

FILTERING

To produce a DIR listing sorted by file name, the author types DIR RRET*.* | SORT (figure 1). When the DOS 2.x DIR command executes, it places the output into standard output. Also, DOS sees the | (vertical bar), which indicates that DIR's standard output will become standard input for the next program. SORT, ignorant of what the input actually is, simply divides the character stream into records in the usual way and sorts them in ascending sequence. It sends the sorted version into standard output. Because the command does not contain another vertical bar or indication of where the SORT output should go, DOS assigns it to default: the screen.

To capture that output to a file, the author could type DIR RRET*.* | SORT > A:DISK.FIL. DOS interprets the > character as a request to *redirect* the output of SORT into the diskette file A:DISK.FIL instead of onto the screen. DIR RRET*.* > LPT1: sends the output of the regular DIR command to the printer. If the user typed DIR RRET*.* > A:MYDIR.FIL to save the current directory values, he could later sort that data by typing SORT < A:MYDIR.FIL. The result would appear, in sorted order, on the screen. The < character tells DOS to use A:MYDIR.FIL, instead of the keyboard, for standard input. Typing SORT < A:MYDIR.FIL > LPT1: sends the same output to the printer.

In a formal UNIX sense, the vertical bar character represents piping: sending standard output from one program as standard input to the other. The < and > functions indicate redirection: character streams are received from or sent to a location other than the DOS defaults (the keyboard and screen respectively). The UNIX nomenclature is used, but the UNIX function and the DOS function are different. In the DOS environment, an underlying unity exists between a piped file and a redirected file.

Writing filters can be easy. In BASIC, for example, the programmer would employ regular INPUT and PRINT statements, which use standard input and output. Thus, any program

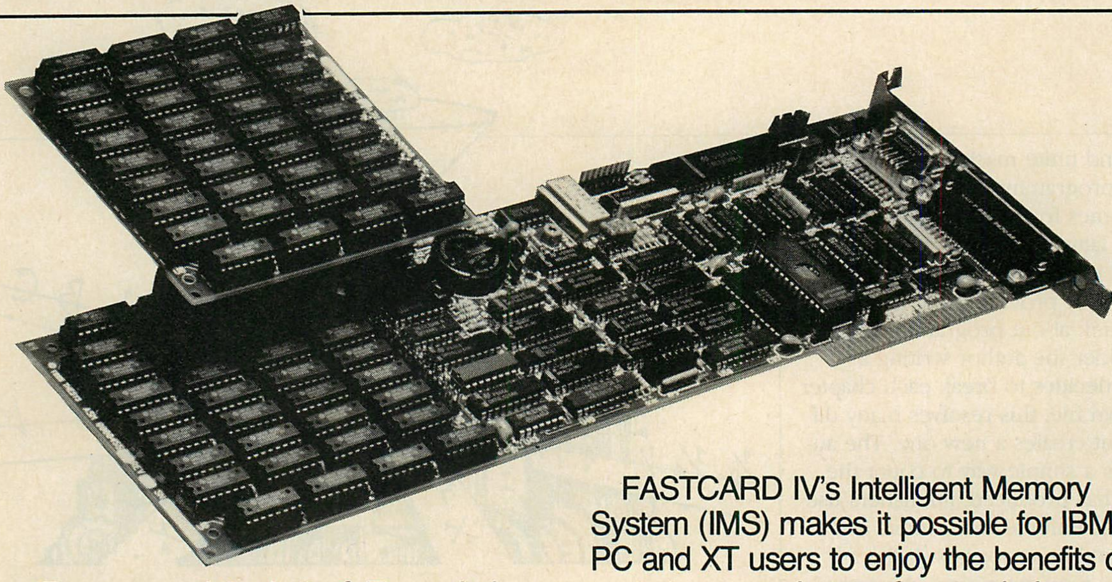


FIGURE 1: *Sample DIR Listing*

```
C>dir b:rret*.* | sort

        25 File(s)      29696 bytes free
 Directory of  B:\
 Volume in drive B is BOOK #1
RRET1    EWF    17408   6-06-85   4:39p
RRET10   EWF     4864   6-08-85  10:40p
RRET11   EWF     8448   6-06-85   9:31p
RRET12   EWF    10368   6-06-85   9:42p
RRET13   EWF    10496   6-06-85   9:51p
RRET14   EWF    11392   6-06-85  10:13p
RRET15   EWF    18688   6-08-85  10:36p
RRET16   EWF    13312   6-06-85   7:18p
RRET17   EWF     8576   6-06-85   7:27p
RRET18   EWF     9472   6-06-85   8:12p
RRET19   EWF    12032   6-06-85   8:25p
RRET2    EWF    13696   6-08-85   9:21p
RRET20   EWF    18304   6-11-85   6:41a
RRET21   EWF     5632   6-11-85  10:15p
RRET22   EWF    11008   6-14-85  10:12a
RRET23   EWF     4224   6-20-85   9:02p
RRET24   EWF     6528   6-20-85  11:33p
RRET3    EWF    12032   6-08-85   9:37p
RRET4    EWF     8832   6-06-85   5:35p
RRET5    EWF    16768   6-08-85  10:02p
RRET5A   EWF    16768   6-08-85  10:23p
RRET6    EWF    17920   6-08-85   2:05p
RRET7    EWF    16640   6-08-85   3:30p
RRET8    EWF    15744   6-08-85   3:26p
RRET9    EWF    15616   6-06-85   9:24p

C>
```

The listing above is output from a filter. It first arranges the characters in the standard input stream into records, then sorts them, and, finally, deposits them in the standard output stream. In this example, the character stream is piped from DIR to SORT.

can be a filter, and its output could be sent to any program that follows it. However, most compilers have trouble with DOS 2.x. Compiler designers continue to use DOS 1.x interfaces to avoid selling and maintaining two different versions. But their customers expect their compilers still to be functional when they buy DOS 2.x. So, DOS 2.x provides all DOS 1.x interfaces. Most compilers, therefore, use the old keyboard and screen interfaces instead of standard input and standard output.

A method is needed to invoke the new standard DOS interfaces. Many languages accept small assembly language programs that would do so; a few, such as Turbo Pascal, can execute DOS interfaces directly. Listing 1, ADDREC.PAS, is a Turbo Pascal program that uses the standard I/O of DOS 2.x. The routines are called GETSTDIN and PUTSTDOUT. Turbo Pascal's INTR function allows DOS and BIOS interrupt handlers to be reached without assembly language. GETSTDIN gets the next byte of input (or, if none, returns the value 255) and PUTSTDOUT puts the next byte into standard output. These subroutines are used in place of WRITELN and READLN to write the utility.

Conceptually, the filter program can be thought of as a "machine" that processes the input and writes the output, one byte at a time. In this case, assume that the input (a stream of bytes) always looks like the output of the DIR command. No set relationship exists between when an input byte is read and when an output byte is written. SORT reads all the input bytes, manipulates them inside the machine of its storage, and outputs them all at once. Another filter might read a single byte, perform its function, and output a byte before reading the next byte.

FINITE STATE MACHINES

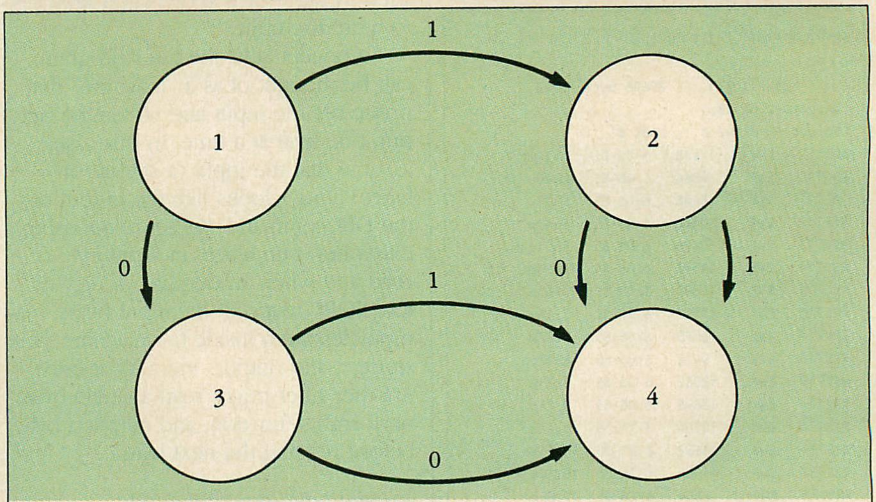
When the workings of such a filter program machine are made up of many similar machines, it is a *finite state machine* and satisfies these criteria:

- It is a collection of a fixed number of preprogrammed smaller machines called *states*.
- Each state examines one input at a time and expects the input to be one of several particular values.
- The state may (or may not) take a special action based on the input and its being in that state. After any such action, the state then gives control of the machine to another state.

SORT does not match this model well, but the original problem of summing file sizes does, especially the part that involves parsing the input. *Parsing*—dividing the input into groups—is very well suited to the finite state machine model. Notice in figure 1 that the output of the DIR command has two kinds of records. The first provides background information—the volume label, bytes free, and so on. The second, which contains the information important to this example, consists of a file name (in the first eight spaces), then a few spaces, the file extension, a few more spaces, then the size of the file (the concern of this exercise), more spaces, the creation date, more spaces, and the creation time.

Before the resolution of this problem, consider a simpler example. The finite state machine of figure 2 performs the binary function AND. State number 1 examines the first input. If the input is 1, nothing is output and state 2 gets control. If the input is 0, state 3 gets control. In state 3, whether the next input is 1 or 0 (and it must be read), the output will be 0. In state 2,

FIGURE 2: *Simple Finite State Machine*



STATE	INPUT	OUTPUT	ACTION
1	1	None	Enter state 2
	0	None	Enter state 3
2	1	1	Enter state 4
	0	0	Enter state 4
3	1	0	Enter state 4
	0	0	Enter state 4
4	None	None	Halts

Execution trace for input string: 1 0

STATE	INPUT SEEN	OUTPUT MADE	NEXT STATE
1	1	None	2
2	0	0	4
4	None	None	None (halts)

The binary function AND is represented above as a finite state machine. The arrows represent possible paths from start (state 1) to finish (state 4).

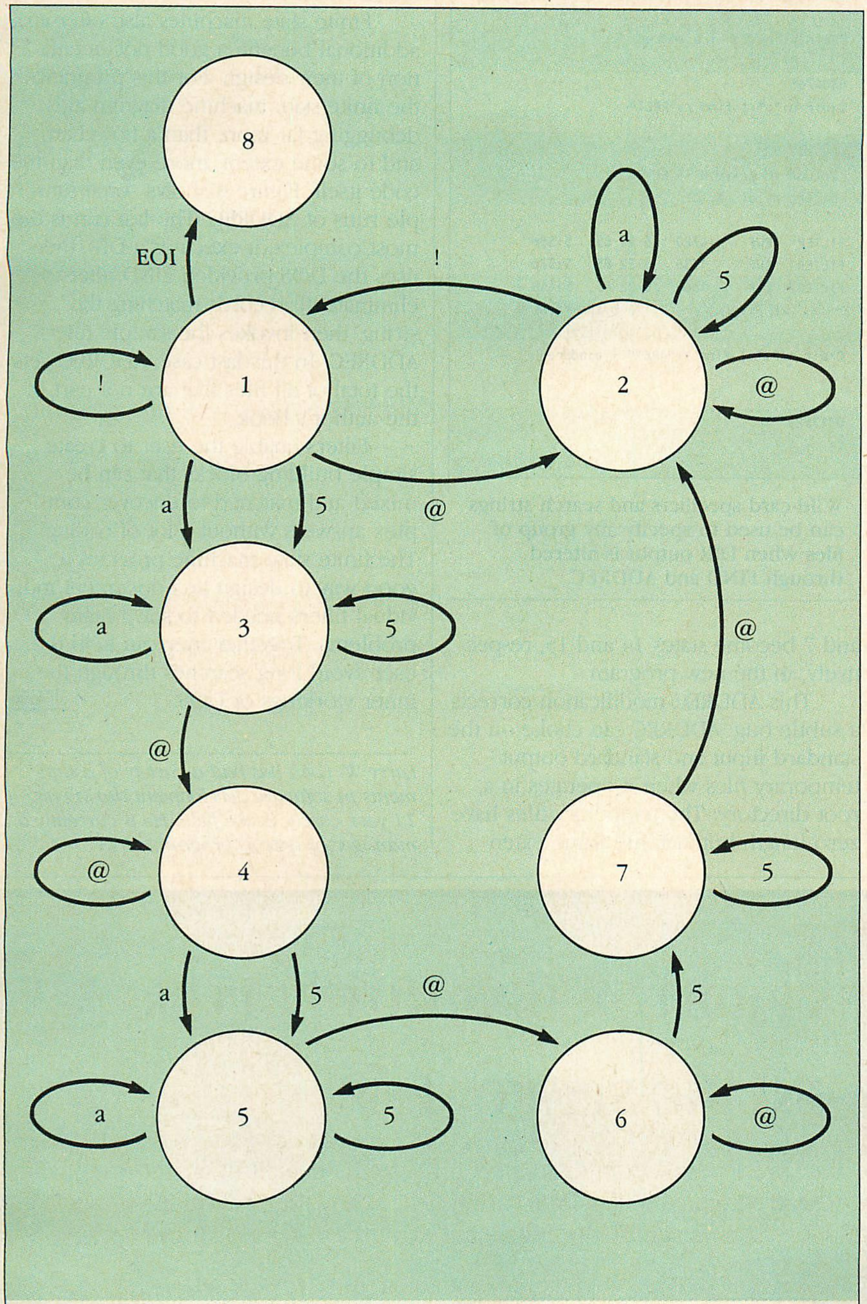
the output is the same as the input, 1 or 0, respectively. Notice that after the second input, all states go to state 4, the only state that does not ask for input. This final state indicates that the machine has stopped. The lower section of figure 2 charts the machine's handling of the sample input string of 1, 0.

The machine for the directory problem is more complex (see figure 3). The first concern is simply graphical—a diagram that explains a parsing operation can become cluttered if keys are not used. Various groups of input are acceptable in parsing. Instead of an arc for each group, it is better to have one arc that represents all of the groups and to key it as such. In addition, the action does not always entail outputting a byte to the standard output. That, too, must be described. The key for this example, located at the bottom of figure 3, describes the actions for each state. Only states 6, 7, and 8 have a special action; the others simply go on to the next state. In some cases, the next state is the same state; this is used to consume unimportant input or for other looping operations.

State 1 has three jobs. Besides detecting end of input, it divides records into two types: those that contain file names and sizes (the target records in this example) and those that contain background information. All records of the second sort begin with a space character. When state 1 detects an initial space character, it enters state 2. State 2 reads in the rest of the characters in the record and puts the machine back into state 1 when a new record begins. States 3, 4, and 5 consume the file name and file type. State 6 absorbs leading spaces, leaving the file size column for state 7; these states read in the number from the record and convert it from a string of characters (which are numbers) to a floating-point number that can be totaled. When the string of numbers in the record ends, the machine goes back to state 2, which consumes the remainder of the record.

A finite state machine can be coded in various ways. Many have elaborate

FIGURE 3: *Example Finite State Machine*



STATE	SPECIAL ACTION
6	Initialize grand total to input
7	If input is number, multiply grand total by 10 and add input to grand total
8	Halt. Print out result onto standard output.

LEGEND	INDICATES
a	Any letter upper- or lowercase. Any character, punctuation, etc., not described below.
5	Any number 0-9.
!	Carriage return or line feed character.
@	Space character (ASCII 32).
EOI	End of input.

This diagram shows how to use a finite state machine to sum the sizes of all files in a directory. This machine reads characters from the input stream. Input characters can be either letters, numbers, or control codes.

tables and very little code. For this example, each state was coded as an individual case block in a case statement (except the final state, which is simply the end of the program). Compare the code in listing 1 with figure 3. The routine GETSTDTY calls GETSTDIN, but also returns the particular character seen and its type. Another routine, OUTANS, converts a string of numbers to characters. While WRITELN easily could have been used for the final output, OUTANS and PUTSTDOUT are more complete. Finally, the program assumes well-formed input. If ADDREC is sent something other than DIR output, it will produce meaningless results (but it will terminate).

ADDREC requires file extensions. If state 4 encounters no extension, it absorbs all spaces before the file size column. State 5 consumes this number, leaving state 7 at the date column. To avoid this, modify the program so it ignores the first 11 characters then absorbs spaces until the file size column is reached. In finite machine language, replace states 3 through 5 with 11 states that absorb a character and increment the state variable. In the ADDREC.PAS listing, replace cases 3, 4, and 5 with 3...13:state:=state+1;. Former states 6 and 7 become states 14 and 15, respectively, in the new program.

FIGURE 4: *ADDREC.PAS*

```
C>dir b:rret*.* | a:addrec

0304768
C>dir b:*.* | find /v"RRET"

 Volume in drive B is NOVEL #1
 Directory of  B:\

FILTER   EWF     14720   6-22-85   5:58p
FILTER1  EWF      1536   6-22-85   5:37p
FILTER2  EWF      1664   6-22-85   5:44p
        28 File(s)     24576 bytes free

C>dir b:*.* | find /v"RRET" | a:addrec

0017920
C>
```

Wild-card specifiers and search strings can be used to specify any group of files when DIR output is filtered through FIND and ADDREC.

This ADDREC modification corrects a subtle bug: ADDREC can choke on the standard input and standard output temporary files when it operates in a root directory. The temporary files have zero length but lack file name extensions, so the original ADDREC reports an incorrect total file size.

Finite state machines also offer an additional benefit: a good documentation of their design. For this program, the finite state machine diagram aids debugging far more than a flowchart, and to some extent, more even than the code itself. Figure 4 shows some sample runs of ADDREC. The last run is the most complex; it executes a DIR, then uses the DOS-provided FIND filter to eliminate all records matching the string, then invokes the sample filter, ADDREC. In this last case, ADDREC gets the total of all files that are not part of the author's book.

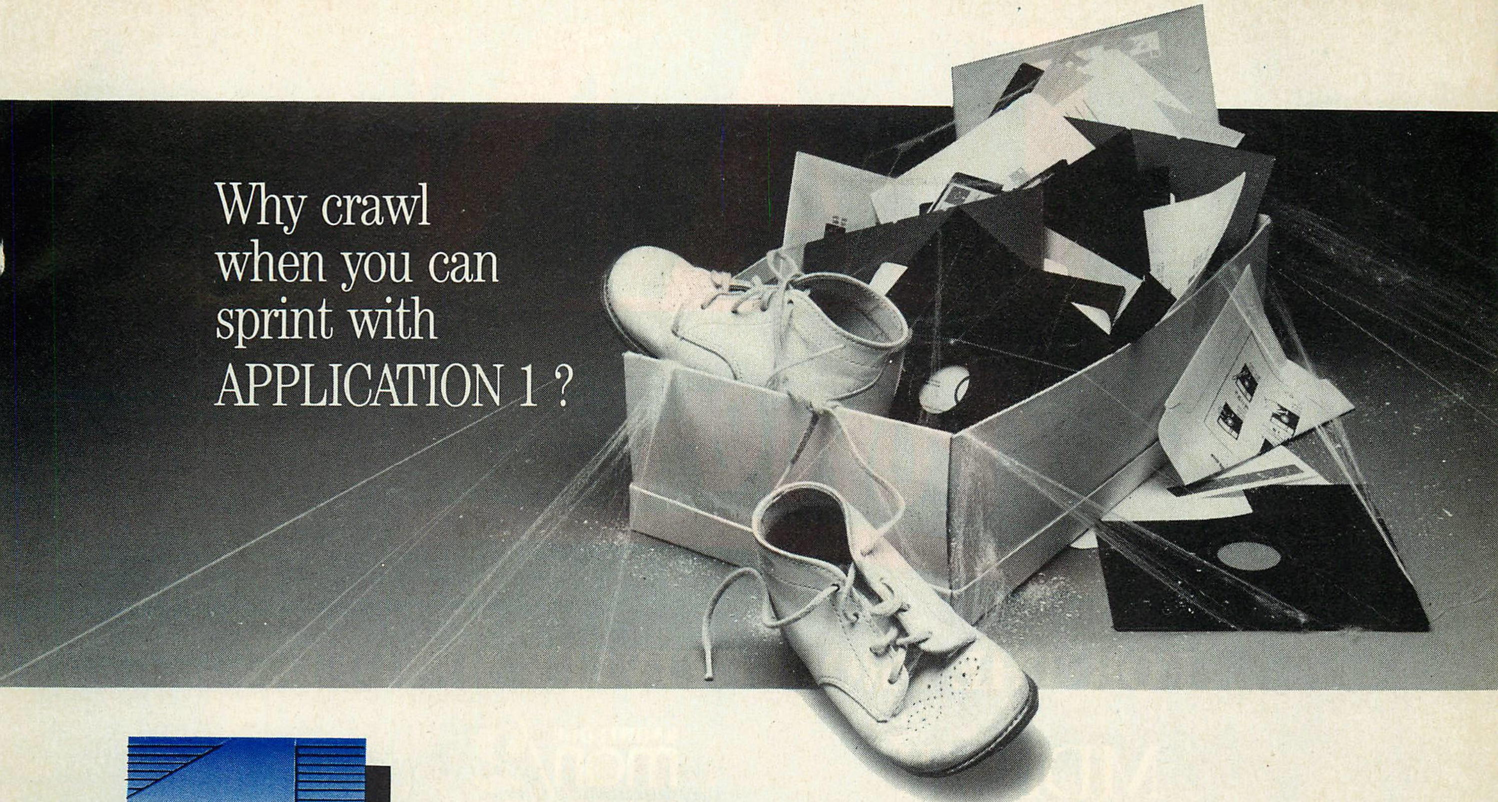
Filters enable the user to create simple building blocks that can be mixed and matched to uncover complex answers without a lot of coding. The finite state machine provides a good way to design and document individual filters needed to solve many problems. Together they can help the user avoid long searches through the inner workings of DOS.

Larry W. Loen has had a variety of assignments in software development during his 11-year career in the field. He is currently a manager of systems programmers.

LISTING 1: ADDREC.PAS

```
PROGRAM addrec;

   { Prints total number of bytes contained in group of files.  Pipe
     directory to addrec with "A>dir | addrec".  The declared types
     are all involved in the get/put of the standard input and output. }

TYPE
     regpack = record
                   ax,bx,cx,dx,bp,si,di,ds,es,flg : integer
               end ;
     ary = byte;
     xpt = record
               case integer of
                     1: (ptx : ^ary) ;
                     2: (qq,rr :integer)
                  end;
VAR
 register : regpack;
 xx : ary;
 here : xpt;
 ip,itype : byte;          { value and type of the input character }
 state : integer ;         { Keeps track of the current state number}
 tot,gtot : real;          { Used to add up the actual answer   }

{ Input and Output procedures follow.  Interface to standard I/O included. }

procedure putstdout(wr: byte);

{  Procedure to put the next byte of Standard Output out to
   MS DOS 2.x Standard Output file. }

   begin
     here.ptx := addr(xx);
     xx  := wr;
     register.ds := here.rr;
     register.dx := here.qq;
     register.cx := 1;
     register.bx := 1;
     register.ax := $4000;
     intr($21,register);
   end;

procedure outans(gtot: real);
{
 This procedure puts out the answer.  Each power of 10
 starting with a million is subtracted from the passed value
 and then put out.  The last digit, the 1's position, has a little
 adjustment because of floating point rounding errors which may
 accrue.
}
VAR digit : byte;
    decnum : real;
begin

   { Write the answer to the Standard Output device. }
   decnum := 1000000.0  ;  gtot:=gtot+ 0.5;
   while decnum >= 1.0 do
     begin
         digit:= ord('0');
         while gtot> decnum do
            begin
               digit := digit+1 ; gtot:=gtot- decnum
            end;
         putstdout(digit); decnum:=decnum/10.0
     end;
 end;

procedure getstdin(var ip: byte);
{
    Procedure to get next byte of input from DOS 2.0, 2.1
    Standard Input file.  This filter uses only ascii characters
    (maximum decimal value 127) so 255 was chosen as the
    end-of-input flag.
}
```

```
begin
     here.ptx := addr(xx);
     register.ds := here.rr;
     register.dx := here.qq;
     register.cx := 1;
     register.bx := 0        ;
     register.ax := $3F00;
     intr($21,register);
     if register.ax = 0 then ip:= 255;
     if register.ax <>0 then ip:= xx;
end;

procedure getstdty(var ip,itype: byte);
{
    Procedure to get the next byte from DOS 2.0 file
    Standard Input AND find out what "type" it is to simplify
    the finite state machine's logic.
}
var iq : byte;
begin
    getstdin(iq);
    ip := iq;
    itype := 0;
    if ip= 32 then itype := ord('@');
    if (ip>= ord('A')) and (ip<= ord('Z')) then itype := ord('a');
    if (ip>= ord('0')) and (ip<= ord('9')) then itype := ord('5');
    if ip = 255 then itype := 255;
    if (ip= 13) or (ip=10) then itype:=ord('!');
    if itype = 0 then itype := ord('a');
end;

begin

  { Here's where the main program begins.  We start in "state 0" by
    initializing a few variables.  Grand total is the final answer.
    Total is set for each record.  Start with grand total as zero.
    The first real state is state number 1, so set STATE = 1 }

  gtot := 0;
  itype :=0;
  state := 1;

 { This loop executes the finite state machine.  When the standard
   input file is empty, exit. }

while itype<> 255 do
  begin
    getstdty(ip,itype);      { Always get the input }

    case state of            { Which state were we last in? }

       1: begin              { State Number 1 }
            if itype = ord('@') then state :=2;
            if itype = ord('5') then state :=3;
            if itype =ord('a') then state := 3;
       {if itype = 255, then handle by falling through WHILE loop }
       {if itype = ord('!'), then state still = 1}
          end;

       2: begin              { State Number 2 }
            if itype = ord('!') then state := 1;
            { else state still 2 }
          end;

       3: begin              { State Number 3 }
            if itype = ord('@') then state := 4;
            {else state still equals 3 }
          end;

       4: begin              { State Number 4 }
            if itype = ord('a') then state :=5;
            if itype = ord('5') then state := 5;
          end;

       5: begin              { State Number 5 }
            if itype = ord('@') then state := 6;
          end;

       6: begin              { State Number 6 }
            if itype = ord('5') then
                begin  { State 6 initializes total as a special action }
                  state := 7 ; { go to state 7 next }
                  tot :=  ip-ord('0');
                end;
          end;

       7: begin              { State Number 7 }
             if itype = ord('5') then
                begin  { If still a digit, continue conversion in tot }
                  tot:= (tot*10) + ip - ord('0');
                end ;
             if itype = ord('@') then
                begin  { If a space, number is converted, add to total}
                  state := 2;
                  gtot := gtot + tot;
                end;
          end;

     end;  { end case statement }
   end;   { end while statement }

      { State 8:  The terminal state of the machine. }
      { And, now, at last, put out the answer }

        outans(gtot);
end.
```



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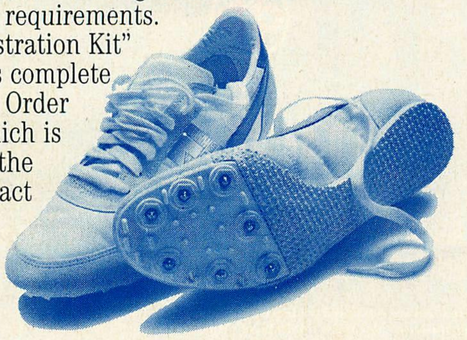

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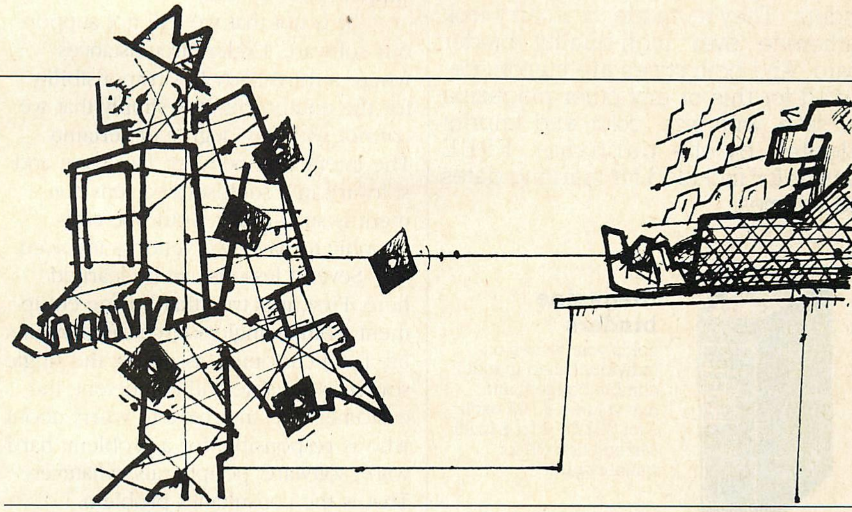
Limits must be placed on consultants who intimidate their customers into buying all hardware, software, and peripherals from a single source: the consultant.



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A lawyer in my office wears both a belt and suspenders. He is also one of the most cautious legal planners in the world. In this month's column, I will look at a consultant who had a belt and suspenders, but in the process of applying epoxy for good measure, he took his pants off.

The following is hypothetical (but only slightly so).

A consultant sold $100,000 worth of equipment and custom software. The documentation of the transaction had the commonplace disclaimers of every type of liability. Shortly after the sale the client received a letter from the consultant saying "your warranty will expire in 90 days and we will be happy to continue to maintain it if you will sign the enclosed agreement and forward the fee." A review of the agreement confirmed that the warranty did expire after 90 days, and the client was convinced that the hardware maintenance fee was money well spent.

The next letter from the consultant suggested that the client, to be really safe, should complete his "total solution" by buying a software maintenance contract as well. This sent the client back to the agreement, which stated:

> "We will install the software on the computer equipment...and shall thereafter keep or maintain (the software) in good working order for a period of 90 days from the date of installation....We make no warranties, either express or implied, with respect to any computer, equipment, or supplies," [a fair limitation for a software vendor] "or as to the software system, of their quality, performance merchantability or fitness for any particular use or purpose other than those warranties which are offered by the manufacturers of these products."

"But," the client protested, "you manufactured the software product."

"True," the consultant replied, "and because we disclaim all warranties, it follows that we are making none. That is why you should buy a service contract on the software."

At this point a fair question would be what type of "service" software might need. It has no moving parts to wear out, nothing to get out of adjustment. It either works or it does not, and if it does not, it is probably because it never did. Not wanting to hurt the consultant's feelings, the client did not raise the argument. Instead, he purchased a "total solution" package of hardware and software maintenance.

All went well until a service representative noticed a standby power supply unit that was not on the list of items covered by maintenance. The client explained that it had been purchased before the hardware maintenance agreement had been signed (and before the client appreciated the importance of a "total solution" approach to computers). Shortly thereafter, a letter from the consultant arrived:

> "The standby power unit currently in use...was, as you explained, purchased locally before signing our hardware maintenance agreement. You should be aware that failure or incorrect operation of this unit which causes damage to the computer or the data on it cannot be our responsibility. If we feel that the unit has directly or indirectly caused a problem we must charge for our services in any recovery needed."

Despite the menacing undertone, the consultant's position seemed fair. If the client bought equipment not covered by maintenance, he would have to take the consequences. The general trend of the relationship was, however, beginning to worry the client. Anxious not to create a disaster unwittingly, the client inquired about the limits of his ability to do anything that would not void a warranty.

The consultant replied that the various parts of a system could not be separated: "computer, printer, software, ribbons, diskettes, etc. all are constituent parts working together toward a planned result."

"Just what precisely is that result?" the client asked.

This prompted another letter in which the consultant proclaimed his frustration with the situation. After all, "while the purchase of a dust cover via mail order is inconsequential in the scheme of things it will lead to diskettes, printers, cables, ribbons, and, finally, complete machines." The consultant could cite a particular case in which one of his clients had independently bought a dust cover, then left it on a machine with the power on, resulting in severe overheating and "you

can use your imagination to think of what kind of damage." The consultant, however, did not charge the client for the replacement because the poor dolt was a valued customer "who would not dream of ordering so much as a diskette from another vendor." (Then where did the dust cover come from?)

"Do you mean," the client asked, "that if I so much as buy a diskette from someone else you will not support your system?"

"It is not that we will not support our software. Under circumstances where a third party has responsibility for the equipment, it is simply that we *cannot* with any degree of certainty. The interaction between hardware and software in a sophisticated...environment is such that it would be catastrophic to have two vendors involved."

Several lessons can be learned here. First, it is true that buying equipment from a single source can simplify life for a customer. Assuming the single source is reliable and competent, the customer does not have to worry about who is responsible for a problem: hardware, software, peripherals, whatever. That is the consultant's problem.

Conversely, if the client chooses to buy from another vendor, he takes two risks: if that product malfunctions it is his problem, and if anything malfunctions he will have to establish that it was not due to the independently purchased product.

Surely, however, limits must be placed on how much fear a consultant should try to instill to keep control over all of the client's purchases.

One such limitation is set by the federal antitrust law, which frowns on conditioning the sale of one product to the purchase of another: a *tying arrangement*. A manufacturer of PCs may not restrict its sale of PCs to only those individuals who agree to buy their printer and all of their future requirements for fan-fold paper from the PC manufacturer. The analysis becomes more complicated when a service and goods are tied together, but if the situation is anticompetitive, the potential still exists for an antitrust violation. The less significant a company's market power, the more latitude it has; perhaps a small consultant can legally demand that his clients do not make a move without his approval (and profit).

A second constraint must also be addressed: the increasing sophistication of computer users. To an increasing number of users, phrases such as "due to the complicated interrelationship of hardware and software we cannot ..." are as likely to convey ineptitude as menace. Their attitude is, "Maybe *you* can't maintain your software if I buy my printer ribbons elsewhere, but there are other consultants who can."

If the tie were justified by a reason other than the consultant's desire for profit from the sale of additional products, it would be defensible both from a customer relations and antitrust point of view. The consultant might be concerned that the purchase of inferior quality diskettes could result in lost data, increased downtime, and excessive service requirements for the disk drives. If so, he could require, as a condition of the warranty, that the customer purchase "double-sided, quad density diskettes from among the manufacturers listed on Exhibit A," or "finest quality diskettes from a reputable manufacturer," or he could specify a brand name. A not-so-subtle distinction exists between those requirements and the requirement that the client purchase his diskettes solely from the consultant. Although a creative consultant might do some random quality control testing to try to justify his involvement, the consultant would be hard pressed to explain the requirement that he be the middleman on the diskette purchase.

Finally, the potential danger in the common practice of copying from someone else's agreement form should be noted. Copying is cheaper than having a customized form prepared (chances are it would look like the one that would have been copied anyway). However, defending an agreement is difficult if it contains provisions the consultant does not understand. A salesman (eager to make a sale) or an executive (backed against the wall by the absurdity of what the form seems to say) may be tempted to state that the meaning of the agreement doesn't matter because the company doesn't enforce it. Adopting such an unreasonable position increases the chances that, somewhere in the process, someone will make a statement that will compromise all of the consultant's careful legal drafting.

The demand for computer consultants is enormous, and it is penetrating to the level of very small businesses. A consultant who feels that the only way to keep customers is to intimidate them would profit more from a long, hard look at its own services.

Max Stul Oppenheimer, PC, is a partner in the law firm of Venable, Baetjer & Howard, located in Baltimore, Maryland.

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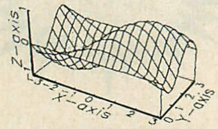

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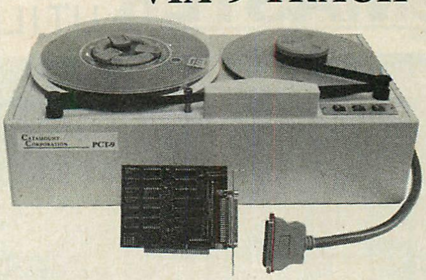

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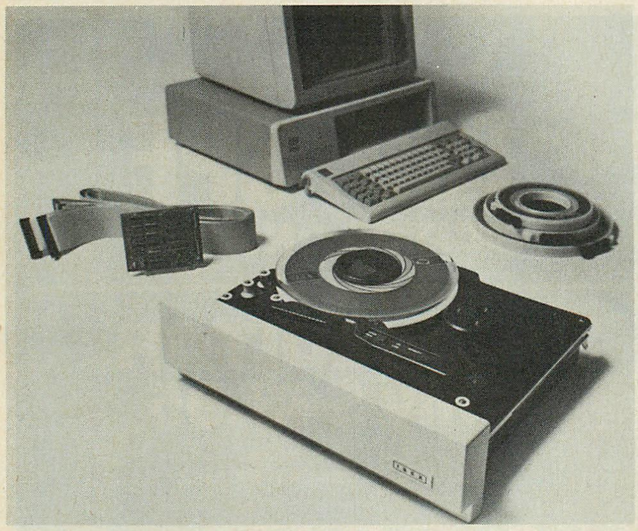

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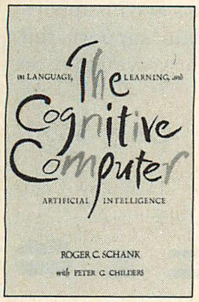
The Cognitive Computer: on Language, Learning, and Artificial Intelligence
Roger C. Shank (Addison-Wesley, Reading, MA 1984) 268 pages, paper, $17.95



Roger C. Shank shares the knowledge he has gained over the past ten years while working as the head of the artificial intelligence lab at Yale in his book, *The Cognitive Computer: on Language, Learning, and Artificial Intelligence*. He frankly confesses both the successes and the failures of his attempts to teach machines to think or, as he explains the thought process, to change as a result of experience, just as human beings do.

Shank explains that humans should not always be required to learn a computer language in order to communicate with their machines. On the contrary, he believes computers should learn a human language. In addition, computers should be able to respond to conversational commands from humans such as "Type the following words in manuscript form" or "Print two double-spaced copies of the article entitled 'My Report'."

The author emphasizes that what the computer should require of the user is not specialized programming language skills, but general intelligence. The computer, he insists, can use the human experiences of the user in order to think on its own.

According to Shank, *artificial intelligence* is a misunderstood term. His definition equates artificial intelligence with "easier to use computers" that can obey human speech as easily as they now respond strokes on a keyboard. Expert systems, which are the result of artificial intelligence, should, for example, allow a doctor approaching retirement to pass on his experience and wisdom to a younger associate.

Three important lessons, the results of the author's experience, are enumerated in the book. First, the author warns the reader that trying to squeeze every book, every index, and every fact into a computer's memory is useless. The machines are not big enough to hold all available information on any given subject, and quantity of memory can become an obstacle to quality of performance.

For example, a surgeon performs many different operations. Perhaps 80 percent of each operation is similar to all the others and requires competence from the surgeon, not expertise. A three-hour operation may require only two or three minutes of specialized hand skills or cutting procedures. However, it is these three minutes that separate the quack from the life saver, and it is these three minutes that belong in an expert system database. The other 177 minutes belong instead in a manual or on videotape.

If a half dozen surgeons were able to combine the secrets of their specialized skills into the database of an expert system, the result would be an oppurtunity for growth and learning now available only from advanced residence training or workshops with the world's greatest surgeons.

To aid in the selection process necessary to determining what should and what should not be included in an expert system database, Shank advocates the use of LISP. This list processor can handle lists from a variety of sources, yet it forces the user to set priorities. In addition, LISP requires that the user have the common sense to recognize situations when the list processor will not work. An expert system may require more than most lists can provide.

As his second warning to the user of an expert system, Shank points out the futility of cramming the rules, procedures, and directions for every possible contingency of a given situation into the system's memory. Assuming that the user could conceive of every contingency, current programming languages do not allow for the algorithms necessary to generalize from rule to rule. If the user enters all the rules for all possible contingencies, the computer must treat those rules as text rather than as algorithms capable of digesting information and returning expert advice.

Instead, the user should enter only those rules he thinks will occur most frequently. This information then can be translated into the language of the computer and debugged to eliminate obvious errors. These few tested algorithms will be more useful than a long list of information.

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Shank's third lesson warns against assigning too many objectives to one expert system. Artificial intelligence must be treated as a useful but limited tool. Robots of the 1980s are able to perform many complicated tasks. In the 1960s, however, they were able to perform only very simple tasks. Twenty years were required to make this transition from simple to complex. Likewise, artificial intelligence programs will require time to evolve before they will be able to handle complex responsibilities.

Shell programs, such as ExSy, can aid in this evolution process, Shank says. A shell program contains no rules of its own; the user provides the program with all the rules it will require to proceed to some logical consequence. If the consequence of a rule is unexpected or incorrect, the user must ex-

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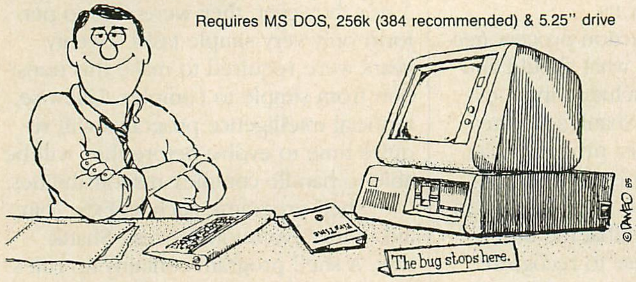

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plain the rule to the shell again and again until the consequence is as desired. This shell approach to artificial intelligence forces the user, as well as the computer, to consider the consistent, logical, and impartial results of a particular rule in a particular situation.

The obvious limitation of shell systems is the intelligence of the user. The system can act only upon the rules as explained by the user. The user must inform the shell if more than one solution is possible and, after the computer has acted, must determine the appropriateness of the solutions reached.

Shell programs, however, are very useful in answering routine and tested questions, and they leave the user free to consider new and innovative questions. Shank emphasizes that expert systems do not replace the user; they allow the user to spend time on challenge rather than routine.

Working to implement artificial intelligence is a calculated risk and not advisable in all situations. Shank helps technical managers determine the odds of the success of an expert system given their particular circumstances. In some instances, even when working with first-rate equipment, experts, and supplies the costs of implementing such a system might outweigh the benefits.

To make the implementation of an artificial intelligence system as easy and beneficial as possible, Shank advises that the manager of the project must guide his coworkers through the change. He must explain specific goals and emphasize why each is important to an overall increase in productivity. In addition, he must make clear the benefits of an expert system to the employees themselves, such as improved working conditions, less worker stress, and the elimination of tedious procedures through the gradual introduction of automation. Documentation provided by the workers involved of the importance of each goal can help the manager motivate the coworkers to achieve that goal, according to Shank.

The author goes on to say that opposition to change is based upon fear and ignorance, not stupidity or stubbornness. Therefore, the manager must be ready to explain patiently the changes involved with the implementation of an artificial intelligence system. He should treat each instance of opposition as a symptom pointing to an invisible need. At first, some goals may seem impossible to obtain. However, the manager's attention to the needs of the workers will prove this not so.

As Shank points out, an expert system implemented on a personal computer cannot solve all problems. For example, if an office or factory has 25 people taking 10 orders per hour during an 8-hour day, the result is 2,000 orders. A single worker using a PC could not handle all of these transactions. Equipping each of the 25 workers with a PC might help, but then problems arise with each computer trying to access a common database, such as an inventory availability program. The solution in this instance would be a mainframe system, not a set of PCs.

Shank is clear and practical in his examination of the question, "What can the PC do to help the office or factory implement artificial intelligence?" He is genuinely concerned about how the computer touches our lives. He explains, "We will be on our way to understanding ourselves...when our machines understand us."

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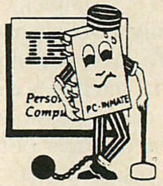

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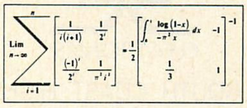

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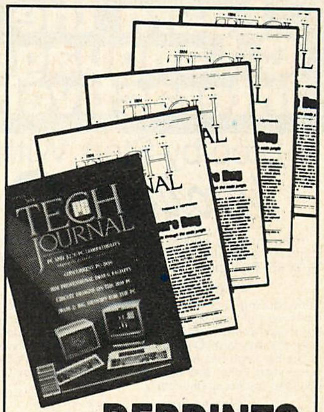

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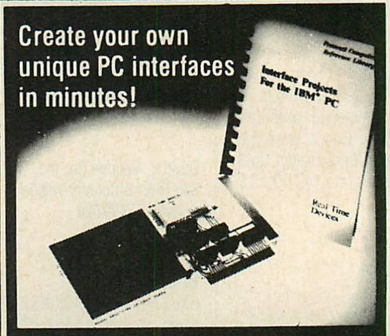

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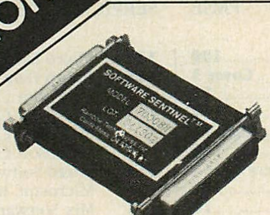

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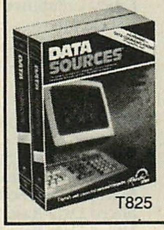

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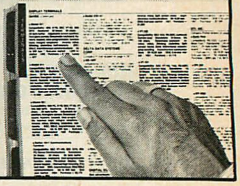

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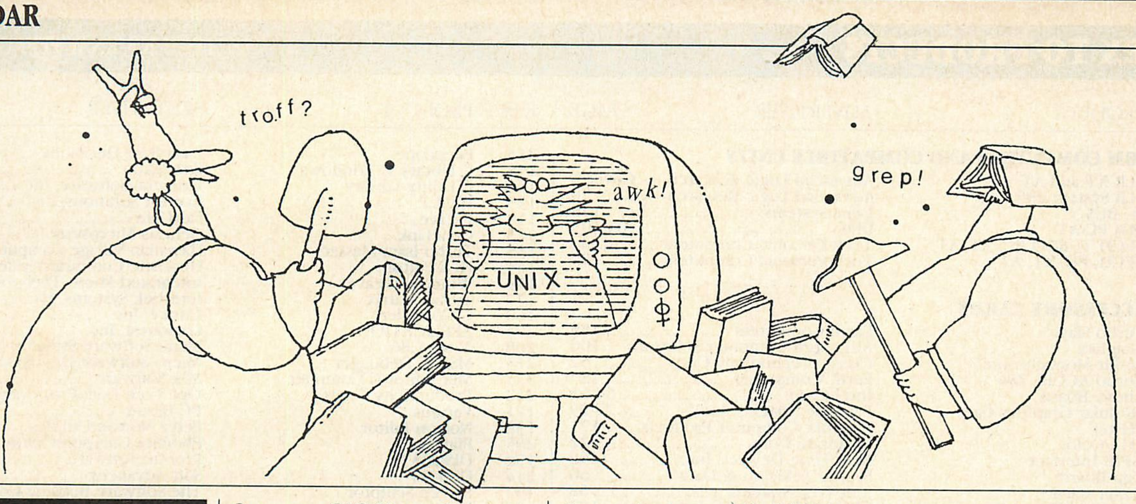

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